ETN's sCO_2 WG survey results

Presentation of 28 January 2022

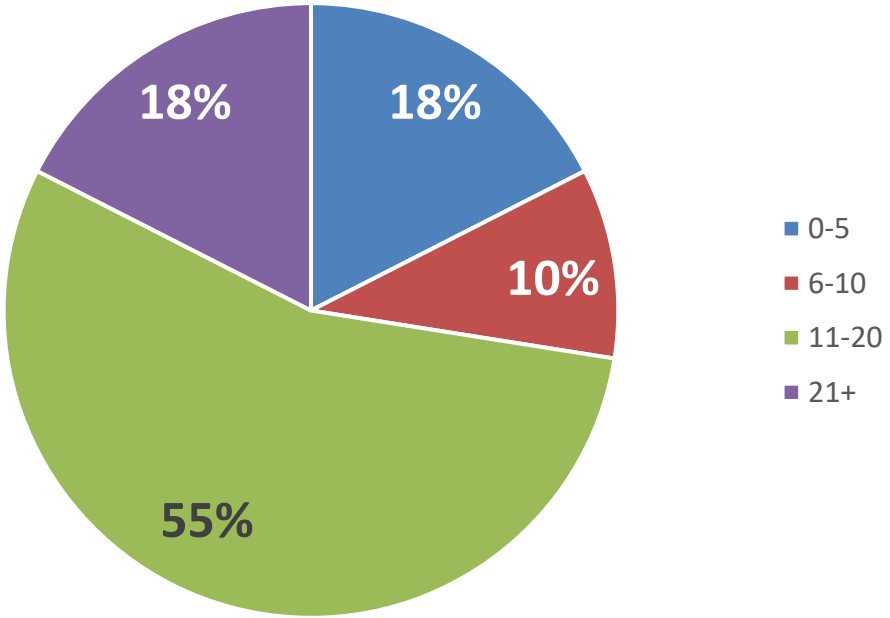
sCO_2 survey introduction

- This survey was **initiated** by ETN's sCO_2 **working group coordination team**
- Its aim was to **identify and frame the needs and recommendations** of WG's stakeholders to support the uptake of sCO_2 technology and its associated market requirements
- Its secondary aim was to **help steering the WG and draw its strategy**
- "**sCO_2 survey task force**" was established, defining the survey's scope and creating the form
- This form was distributed via various channels in Autumn 2021
- Replies were analysed during January 2022
- WG's chairman **presented the survey results in the WG meeting on 28 January 2022**
- ETN's sCO_2 WG intends to **further extend the survey's database** by means of various sCO_2-related events

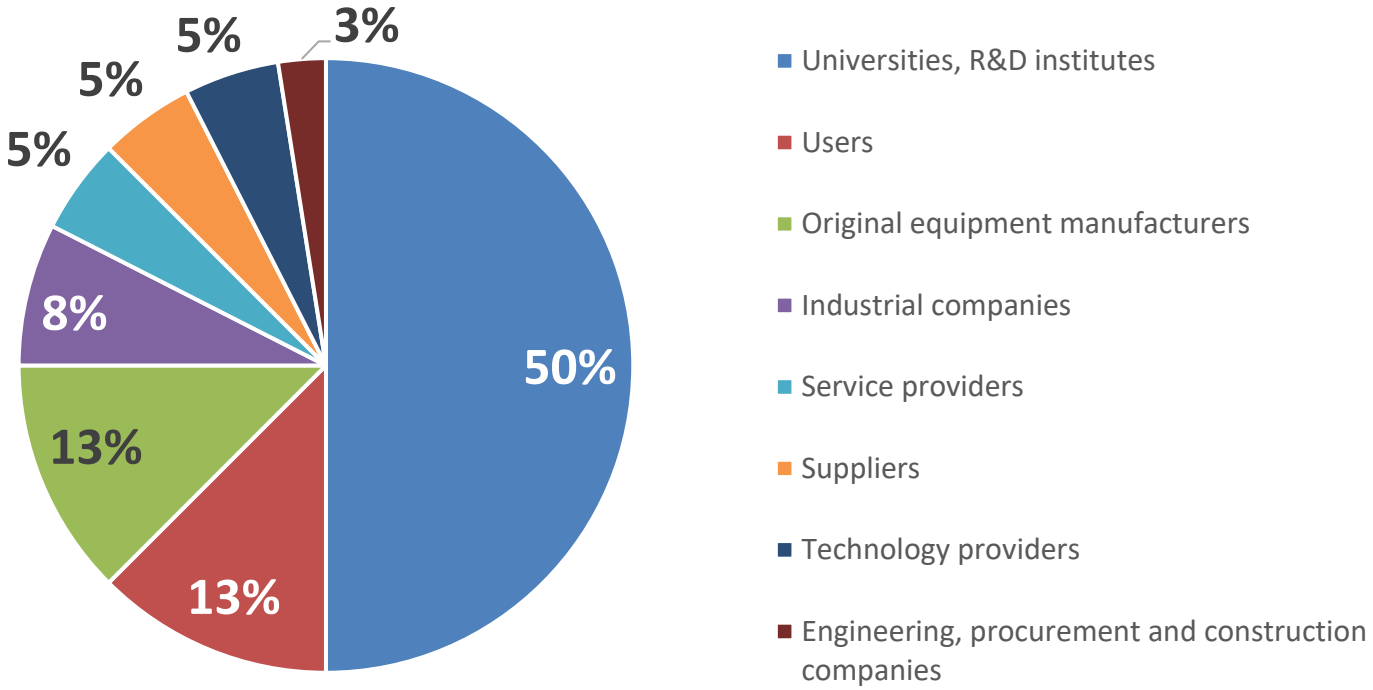
sCO_2 survey results

- **40 replies**
- **Various respondents**
  - ETN sCO_2 WG
  - sCO_2-related project partners
  - Other relevant stakeholders (via LinkedIn, ETN monthly newsletter)
- 6 respondents **(15%) recruit from SMEs** (<250 employees), 9 (23%) from organisations with 250-500 employees, the rest (25/62%) from organisations with more than 500 employees
- Half of the respondents works in **Research & Development**, while the second half holds various **Engineering technology & Product managements** posts
- Vast **majority of respondents works in Europe (88%)**. The remaining 12% are distributed among Americas, Asia, and Middle East

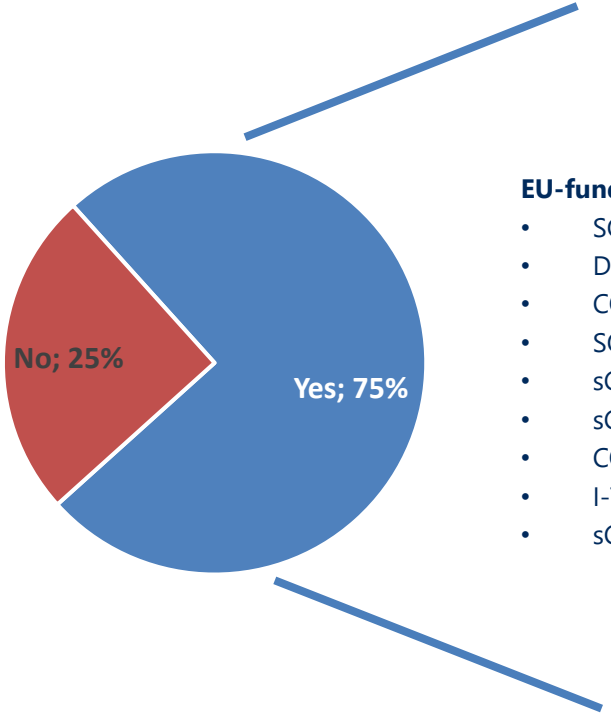
Length of your career in the current sector (years)



Sector of your professional activities



Are you participating in any sCO_2 funded programme?



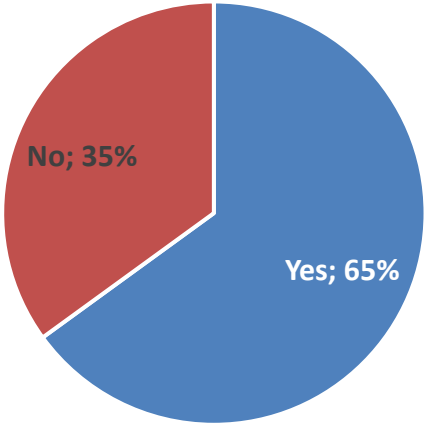
EU-funded projects

- SCARABEUS
- DESOLINATION
- CO2OLHEAT
- SOLASCO2OL
- sCO2-Flex
- sCO2-4-NPP
- COMPASsCO2
- I-Therm
- sCO2-HeRo

National projects

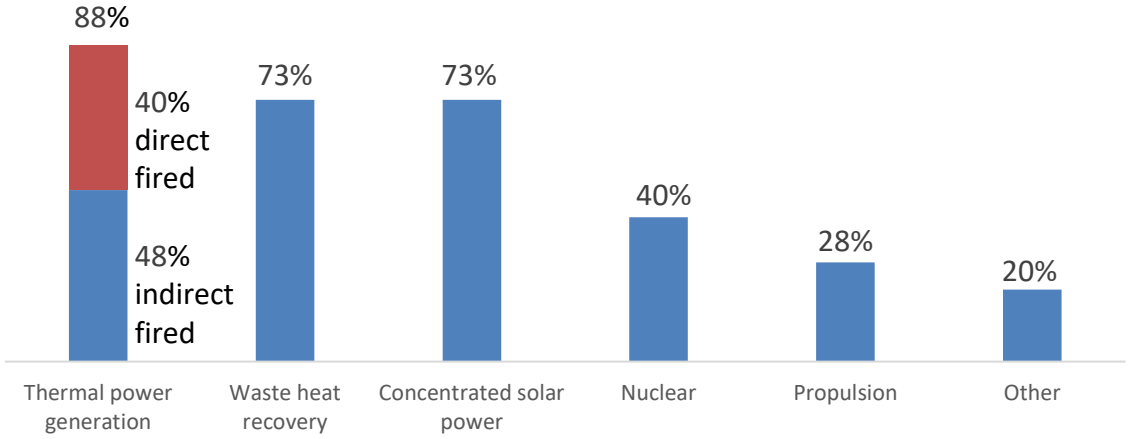
- SCOTWOHR (UK)
- GTI STEP (US)
- Design application for sCO_2 cycle engine (RO)
- Carbosola (DE)
- sCO2-MA (DE)
- sCO2-QA (DE)
- Project(s) with CERN
- Czech national projects
- Oxy-combustion sCO2 gas turbine at KEPCO (South Korea)
- sCO2 compressor fluid-dynamic simulation

Has your organisation performed an assessment of the applicability of the sCO_2 technology?



Respondents filling the survey have already assessed the technical and economic feasibility of sCO2 technology in applications such **as WHR, CSP and conventional power and Combined Heat and Power (CHP) generation**, including **applications with carbon capture, utilisation and storage**. These assessments include system analysis and also feasibility of component development (expander, compressor, heat exchangers).

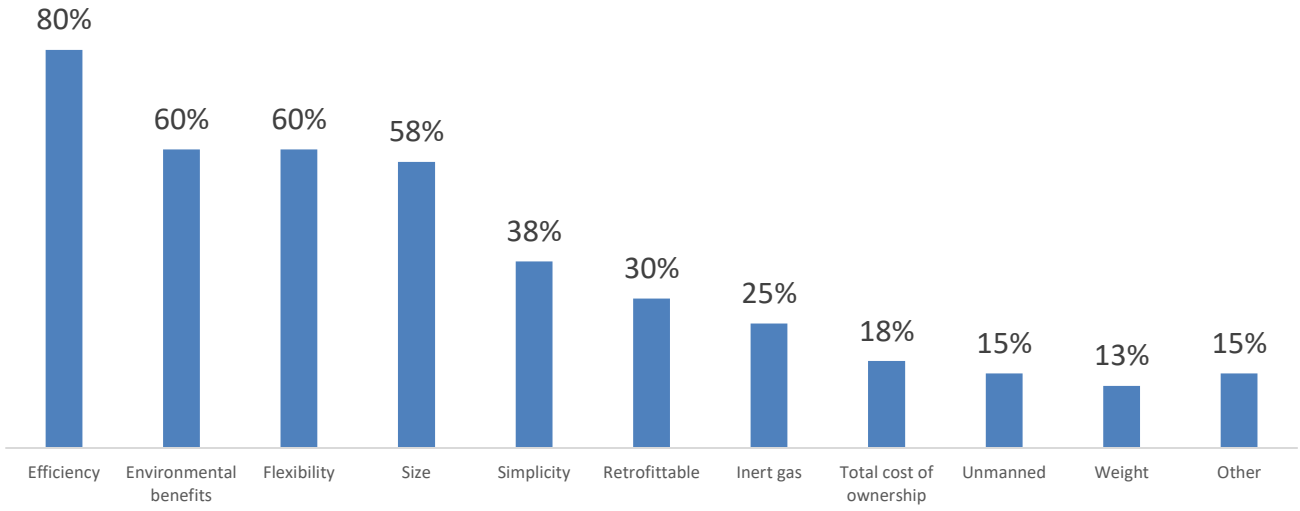
Which applications do you see fit for the technology? (more answers possible)



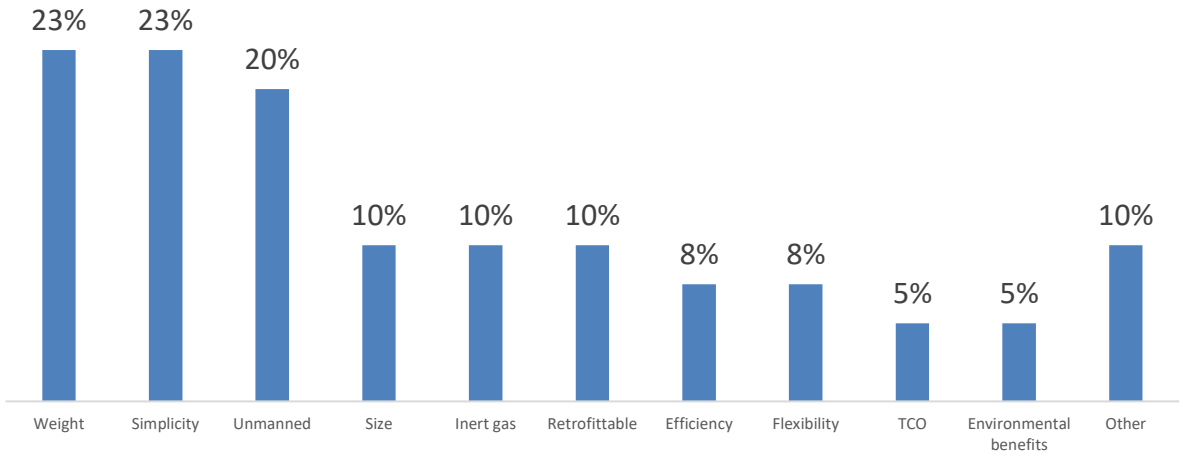
Power generation from **combustible (renewable and non-renewable) energy sources, waste heat and solar energy** are seen as the most likely applications of supercritical CO_2 technology, followed by **nuclear power** and, to a lesser extent, **marine propulsion.**

**Other: distributed (small-scale) power generation, geothermal, energy storage*

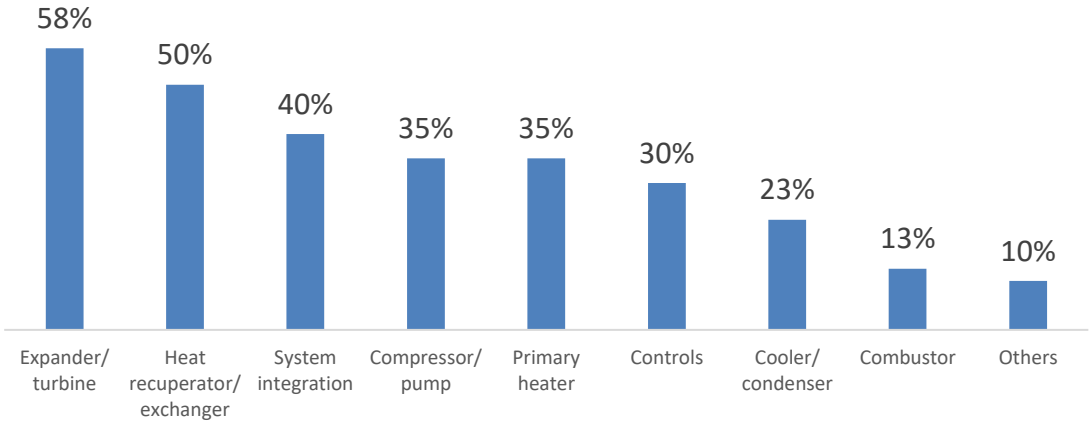
What are your key drivers? (more answers possible)



What would be an acceptable trade-off for you/ what are you willing to sacrifice to gain that driver? (more answers possible)



Which component, according to you, needs the most development? (more answers possible)



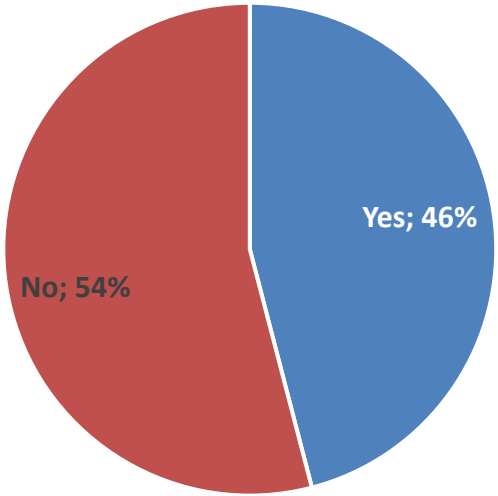
High and low-temperature **heat exchanger technology is needed**: **coolers** able to enable compression at high density, in particular in warmer climates, and primary heaters able to operate at >700ºC. **Expanders** for this high temperatures must also be demonstrated at relevant scales (10MWe). Finally, **system integration is still seen as an open question**: mechanical drive of compressors, part-load equipment, controls, etc.

If you ever looked at waste heat, have you considered alternatives (steam, ORC)?

Comments:

- Most respondents filling the survey and working on waste heat applications **have also considered steam and organic Rankine cycles as an alternative to sCO_2 cycles** (or vice versa).
- In the main, **ORCs are seen suitable for lower temperature applications**, with the main disadvantages of difficult upscaling and the need for an intermediate heat transfer loop in certain applications with hazardous working fluids. **Limited efficiency is also a concern**.
- **Steam is less popular than ORC** for future WHR applications and, whilst it is also interesting, it is reported to **exhibit less flexibility** and to require **more bulky and expensive components**.
- Some surveys reports **scepticism about the viability of sCO_2 systems** in WHR applications
- There seems to be **consensus that sCO_2 systems are more interesting at temperatures higher than 400ºC**

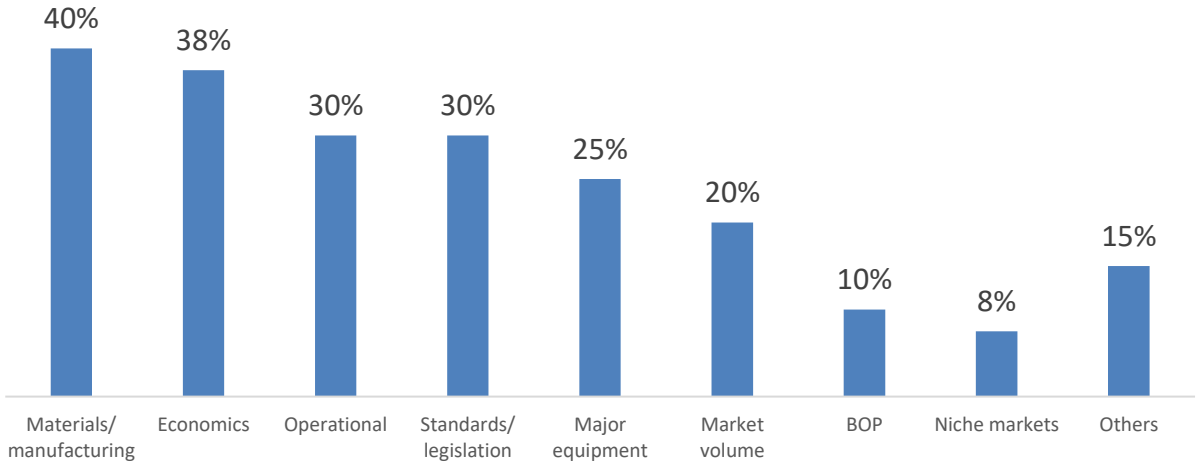
Would your company be willing to host a pilot/demo installation?



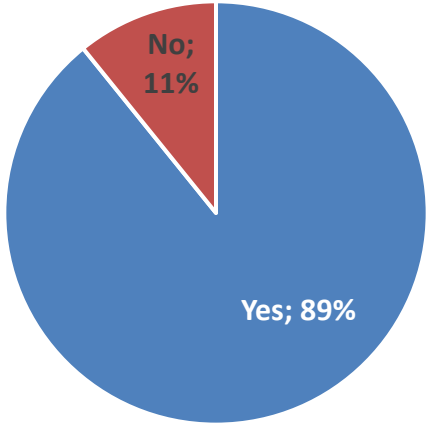
For "No" a variety of reasons were offered by the potential host:

- budget/project too expensive or complex
- safety/manageability
- not aligned to business
- site conditions or constrains

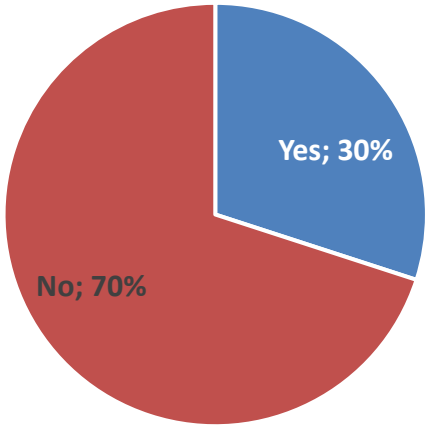
What area of sCO_2 applications (either technical or related to market uptake) is currently being overlooked the most? (more answers possible)



Is your organisation willing to engage in joint actions and to share (limited) proprietary data under appropriate NDA protection?

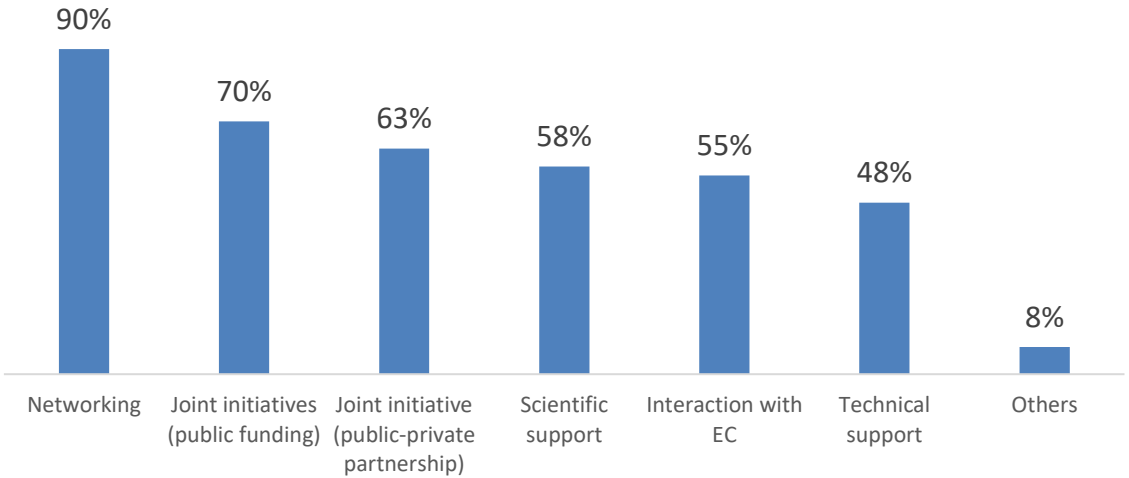


Does your organisation have sCO_2 facilities (either laboratory or pilot scale)?



Several test rigs available, most being in the 50kW-2MW. Pressures up to 250bar and limited temperature (550°C)

What kind of interaction is your organisation looking for in ETN's sCO_2 WG? (more answers possible)



Thank you for your attention and survey participation!