



FFPLUS SUCCESS STORY: BUSINESS EXPERIMENTS

HIGH PERFORMANCE CENTRIFUGAL COMPRESSOR FOR SUPERCRITICAL CO₂

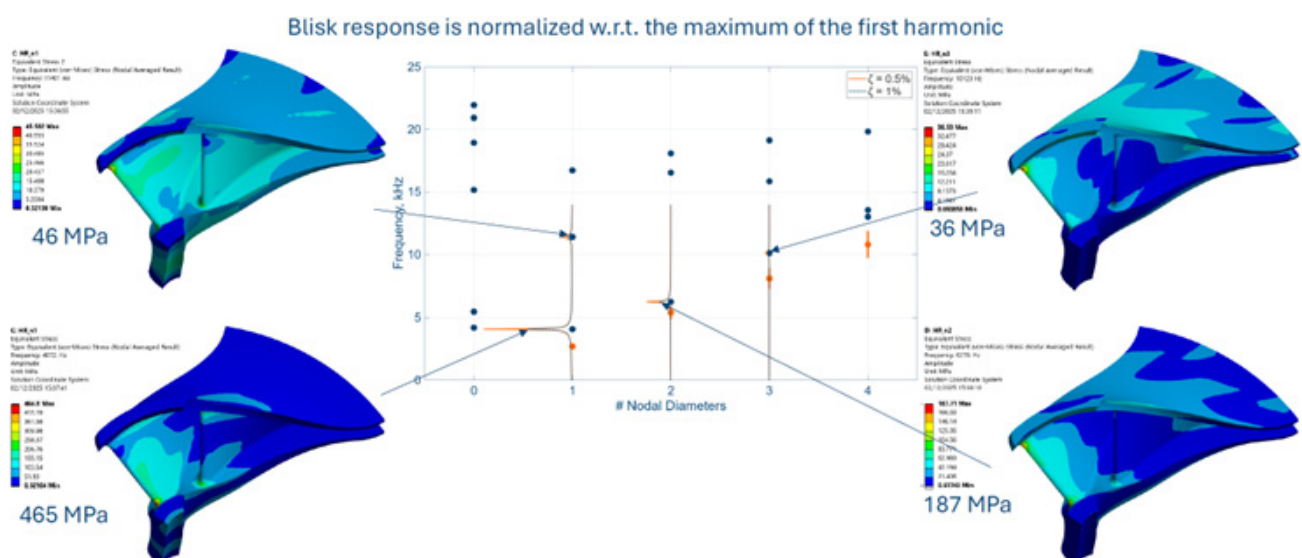
ORGANISATIONS

Compression Service Technology S.r.l. (CST) is an Italian engineering company with 50+ years of rotating machinery experience, designing centrifugal compressors from first principles and covering specialist aerodynamic and mechanical calculations. **Ergon Research S.r.l. (ERG)** is a research and consultancy company, formerly a University of Florence spin-off, specialising in HPC-based simulation, with 35+ experts and a 1,000+ core cluster.



THE CHALLENGE

Demand for supercritical CO₂ compressors is rising as CCUS and decarbonisation projects scale across steel, cement and oil and gas. CST was receiving OEM requests but lacked a validated design route. Near its critical point, sCO₂ is too complex for standard tools, while testing prototypes is costly and slow. Multiple geometries and operating points required high-fidelity CFD at a scale only HPC could deliver.



Technology used: HPC, CFD, FEM
Industry Sector: Energy

THE SOLUTION

CST and ERG created a reusable design workflow for sCO₂ centrifugal compressors, combining accurate fluid modelling, CFD aerodynamic analysis and FEM structural checks. Using NIST thermodynamic data and the Discoverer supercomputer, they evaluated designs operating up to 23,000 rpm. HPC enabled models with up to 100 million elements feasible, by using 10,000-30,000 CPU core hours per run and up to 1,024 cores to deliver swift results for significant engineering decisions.

THE IMPACT

The project gives CST a validated sCO₂ compressor design capability, allowing it to respond to OEM opportunities it previously had to decline and enter a specialist market served by only a few global suppliers. A proven reference design strengthens CST's credibility with customers and creates a pathway to an estimated +€1million/year from two design orders per year from the end of 2027. The HPC workflow is also reusable for other non-conventional compressor sizes and fluids, reducing future design effort by 40-60% and helping CST scale its offer without relying on slow, high-risk physical prototyping.

For ERG, the study validates a commercial HPC service that combines CFD and FEM for rotating machinery, supporting an estimated +€650,000/year from OEM clients and research programmes. For customers, the outcome provides faster access to reliable sCO₂ compressor engineering, shorter development cycles and reduced cost and risk in CCUS-related projects.

BENEFITS

- CST can now pursue sCO₂ compressor projects previously declined.
- Validated HPC workflow reduces future design effort by 40-60%.
- HPC enabled 100M-element CFD/FEM models impractical on workstations.
- Forecast revenues: +€1 million/year for CST and +€650,000/year for ERG.
- Discoverer ran 10,000-30,000 core-hour simulations on up to 1,024 cores.



Funded by
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Joint Undertaking