sCO2flex

Supporting the electricity system

by making fossil fuel based electricity production more flexible

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The challenge

The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels, by 2050. The EU 2050 Energy Strategy includes therefore new challenges and opportunities.

Renewable energy (such as wind and solar) is gaining momentum and now raises the question of grid stability in the event of large power output fluctuations.
In this context, enhancing the flexibility and the performance of conventional power plants is seen as a good opportunity to both secure the energy grid while reducing their environmental impact. Therefore, it is necessary to develop innovative and cost-effective ways of enabling existing and future fossil fuelled power plants to be flexible enough to deal with load fluctuations and also to reduce emissions.

The sCO_2-flex consortium seeks to develop a scalable/modular design of a 25MWe Brayton cycle using supercritical CO_2. This will enable an increase in the operational flexibility (fast load changes, fast start-ups and shut-downs) and efficiency of existing and future coal and lignite power plants, thus reducing their environmental impacts, in line with EU targets.

Supercritical carbon dioxide (aka sCO_2) is a fluid state of carbon dioxide where it is held at or above its critical temperature and critical pressure. The fluid presents interesting properties that promise substantial improvements in conventional power plant system efficiency.

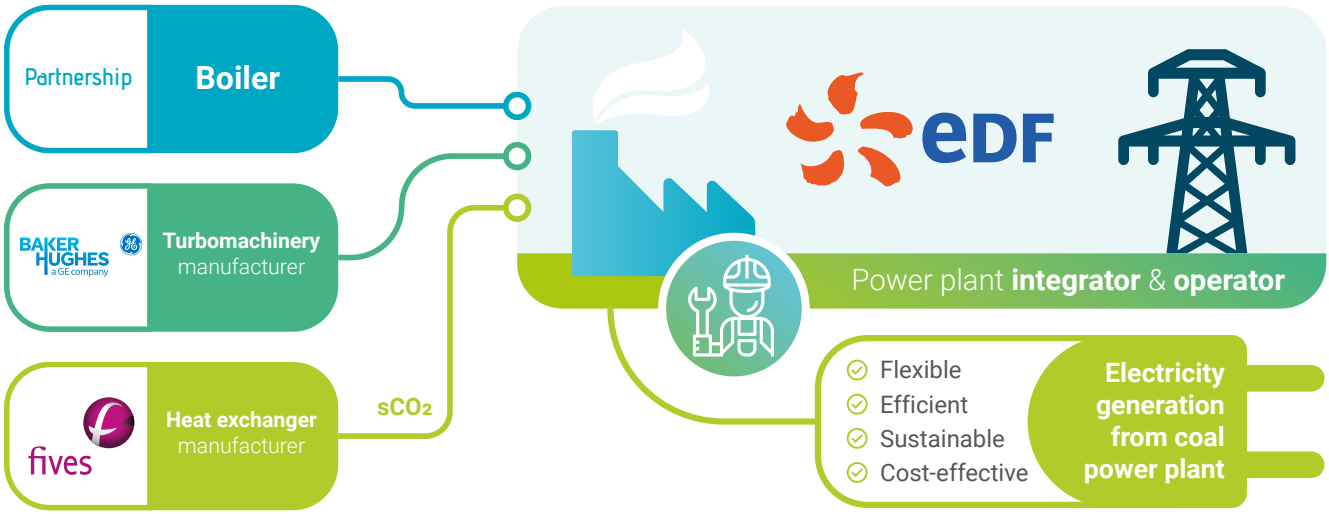
Due to its high fluid density, sCO_2 enables extremely compact and highly efficient turbomachinery. sCO_2 based technology therefore has the potential to meet EU objectives for highly flexible and efficient conventional power plants, while reducing greenhouse gas emissions, residue disposal and also percentage water consumption reduction.

sCO_2-FLEX is an EU-funded project led by French Utility EDF that brings together researchers, technology providers and industry experts covering the whole value chain. The aim is to demonstrate how supercritical CO_2 could contribute to Europe's climate change and energy transition goals by making fossil-fuelled power production more capable of supporting a smarter and more flexible energy market.

The project involves building expertise on sCO_2 for electricity generation and project leader EDF is also interested in investigating its possible application to renewables such as CSP (Concentrated Solar Power) and biomass.

This project has secured a grant worth €5 million from the European Commission's Horizon2020 Programme will run for 3 years.

sCO_2flex industrial & commercial **value chain**



Making fossil fuel-based electricity production more flexible

The sCO₂flex project seeks the fulfilment of the following objectives:

1- Technical.

Increase in fossil-fuelled power plant operational flexibility by:

- Developing and validating advanced equipment (boiler, turbomachinery system, compact heat exchangers and materials concepts), contributing to increased modularity and reduced maintenance costs;
- Enabling entire load range optimisation with fast load changes, fast start-ups and shutdowns;
- Designing a 25 MWe facility employing the sCO₂ cycle ready for implementation in a demonstration project, from 2020 onwards.

	sCO₂-Flex	**Coal** (state of the art)	**Coal** (current Average	**Lignite** (state of the art)	**Lignite** (current average)	**CCGT*** (current average)
FLEXIBILITY CRITERIA						
Minimum Load	20%	25%	40%	50%	60%	40%
Ramp-rate % nom load/min	> 6	4	1,5	2,5	1	5 - 6
Hot start in h. (after <8 hours off)	< 2	2,5	3	4	6	1
Cold start in h. (> 72 hours off)	< 4	5	10	8	10	3
EFFICIENCY CRITERIA						
Efficiency at nominal load	> 48%	46%	33%	43,5%	36%	55 - 60%

* Combined Cycle Gas Turbine

2- Environmental and social.

Mitigating coal and lignite plant environmental impacts and fostering the acceptance of sCO₂ technology by:

- Drastic reduction of water use in the thermodynamic cycle/heat rejection section, employing air-cooling instead;
- Reducing CO_2 emissions and fossil fuel consumption for an equivalent power output;
- Reducing the quantity of metal alloys needed for turbomachinery and the overall environmental footprint of the plant by at least 25% by decreasing the size of power block components/ increasing power density.
- Foster the social acceptance of the sCO₂ technology

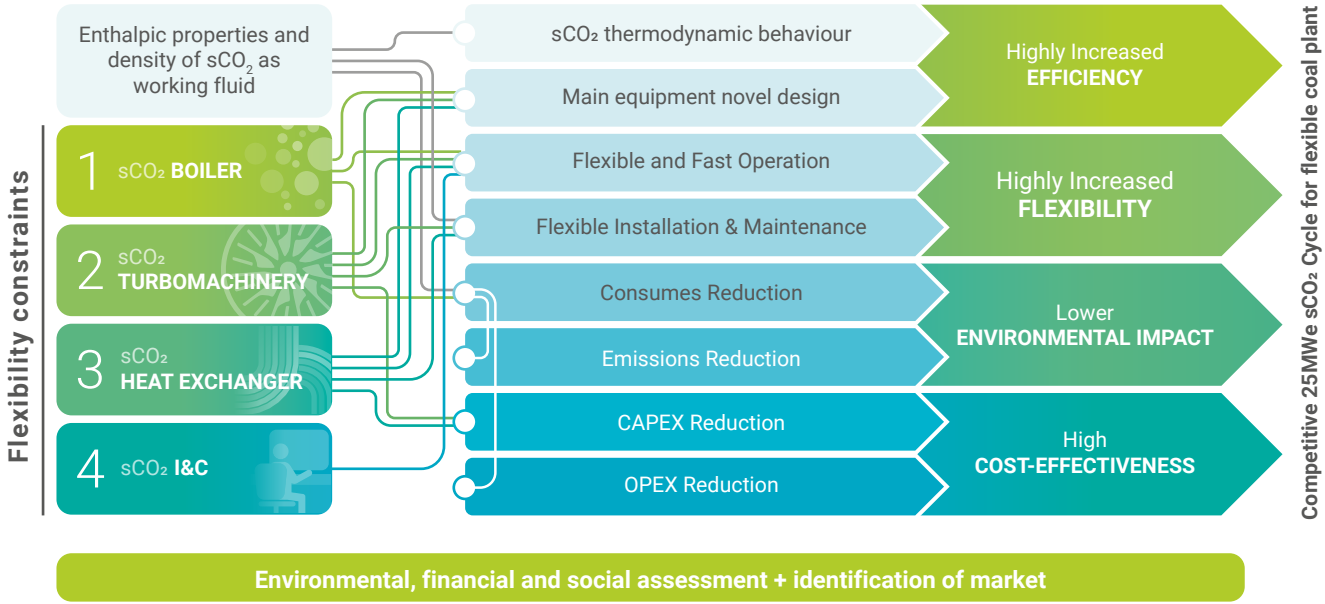
Coal power plant of Weisweiler, Germany - x1klima on Flickr

3- Economic.

Enabling market uptake and industrial deployment of the flexible supercritical CO_2 Brayton cycle from 2025 by:

- Establishing the sCO_2 Brayton cycle as an optimal technology in terms of operation and maintenance costs through optimised design and component integration;
- Achieving a levelised cost of electricity (LCOE) for coal and lignite fuelled sCO_2 Brayton cycle plants that is 6 to 16% lower than the estimated LCOE of future supercritical coal plants with CCS.

How sCO_2flex plans on **overcoming the technological barriers** and **reach its objectives**?



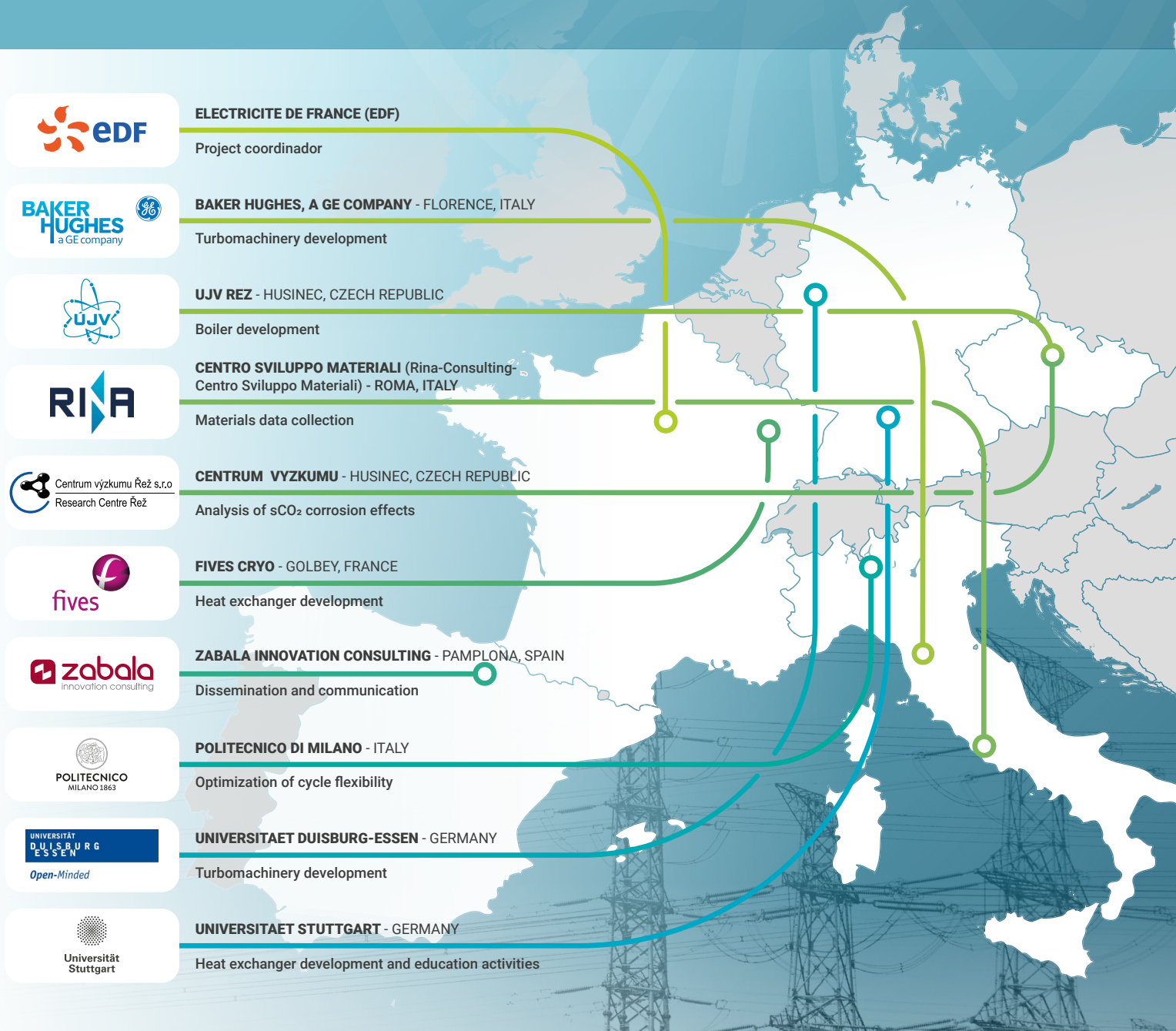
sCO_2Flex alliance:
Increasing sCO_2-related knowledge:

As the sCO_2 community grows, the sCO_2-Flex partners will contribute to the overall enhancement of the knowledge basis in the field of sCO_2, at national and EU levels and at academic and industrial level. To capitalise on this knowledge and to foster exchange of best practices related to sCO_2-based technologies at European level, the sCO_2-flex partners will set up the "European sCO_2 Alliance".

The alliance, gathering all relevant stakeholders, will organise several workshops and webinars dedicated to sCO_2 helping to foster dialogue and knowledge-sharing. More specifically, it will be set out to:

- Generate, share and transfer scientific and technological knowledge to foster Research and Innovation projects;
- Unlock long-term collaborations between universities, technological centres, technology providers, operators, contributing to strengthening the innovative and competitive capacity of the members
- Act as a platform, monitoring international, EU and national projects related to sCO_2 to maximise the added value generated by these projects
- Discuss short-term, mid-term and long-term strategic Research and Innovation priorities

Consortium



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Materials data collection

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Analysis of sCO_2 corrosion effects

FIVES CRYO - GOLBEY, FRANCE

Heat exchanger development

ZABALA INNOVATION CONSULTING - PAMPLONA, SPAIN

Dissemination and communication

POLITECNICO DI MILANO - ITALY

Optimization of cycle flexibility

UNIVERSITAET DUISBURG-ESSEN - GERMANY

Turbomachinery development

UNIVERSITAET STUTTGART - GERMANY

Heat exchanger development and education activities

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