EERA joint programme on CO_2 Capture and Storage

Recent advances and the road ahead

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Ruud van den Brink – ECN

Sergio Persoglia – OGS

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Outline

- CO_2 Capture and Storage: current status
- European Energy Research Alliance Joint Programme on CCS
- Example: The SEWGS CO_2 capture technology

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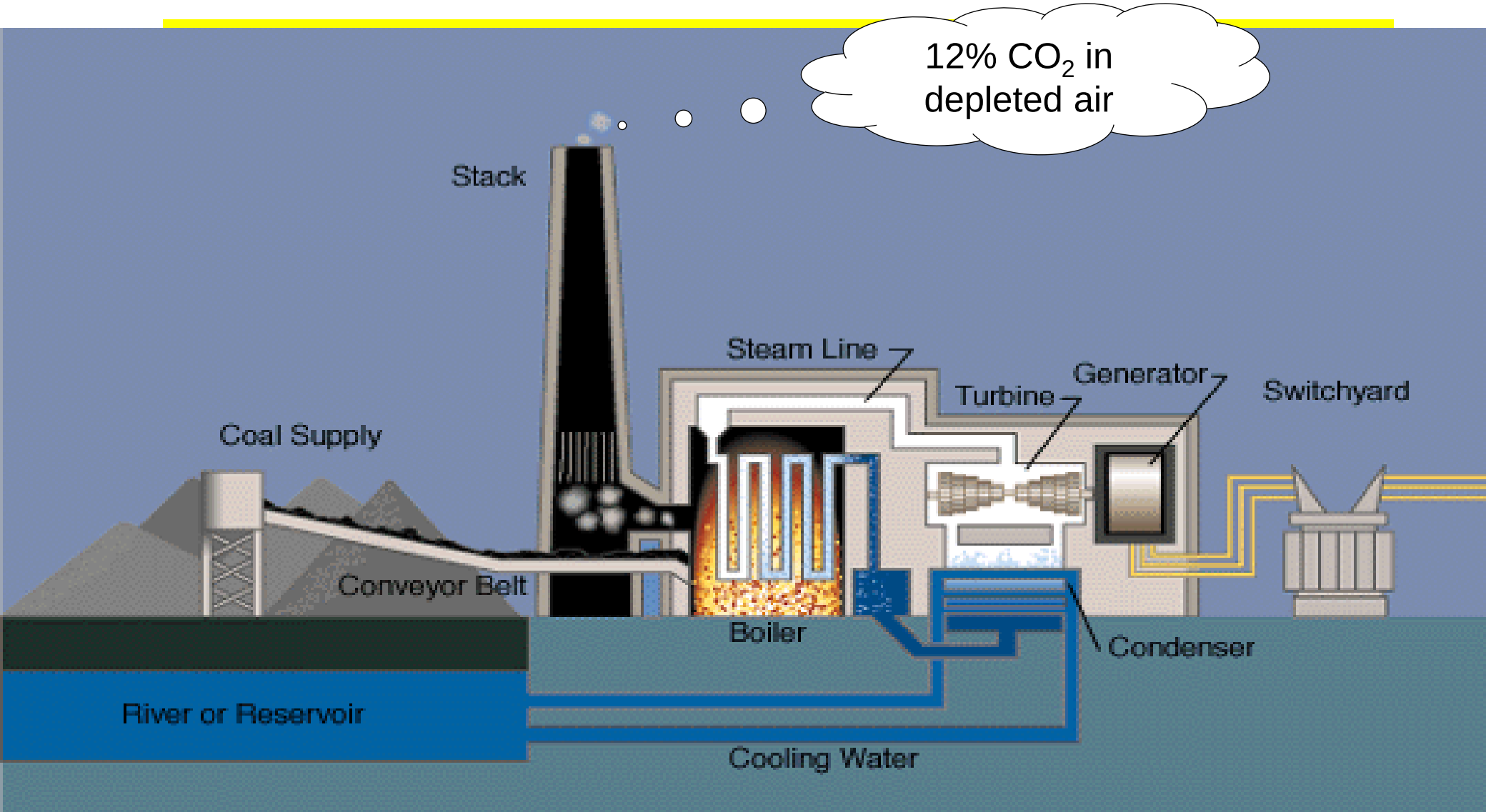
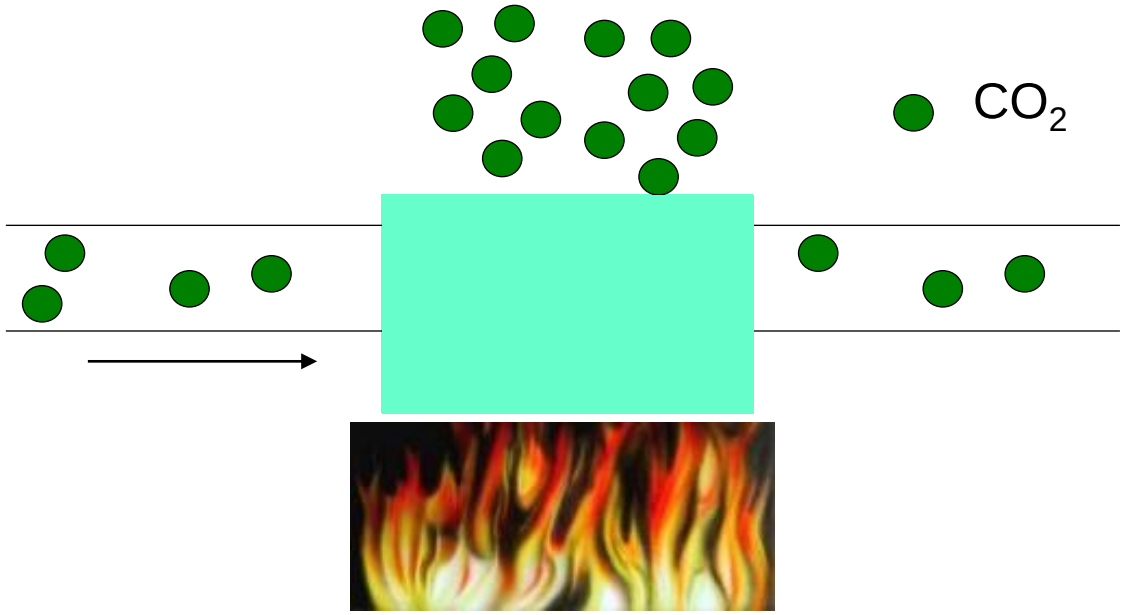
A thermal coal-fired power plant



Conventional CO_2 removal from flue gas of power plants

- CO_2 is captured by a amine solution
- Regeneration costs a lot of energy



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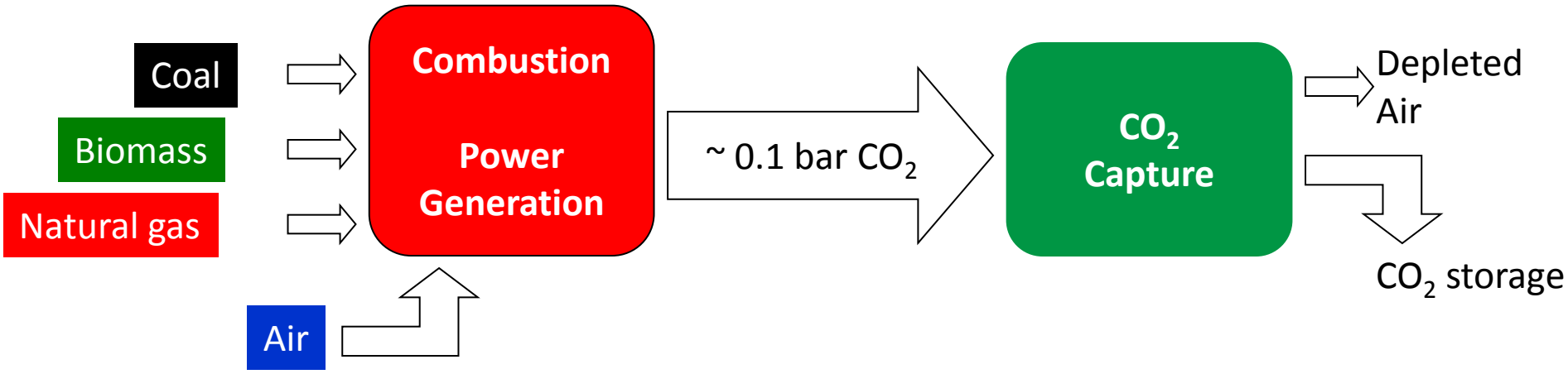
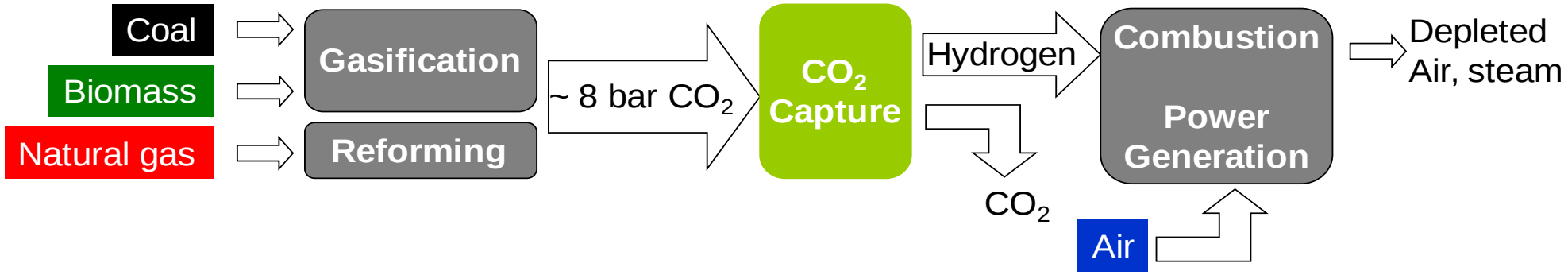
Post-combustion CO_2 capture



+ 'Standard' power plant
+ Retrofit to existing power plants is possible
- High efficiency penalty
- Not yet proven on large scale in power plant
- Solvent losses, environmental pollution

Pre-combustion CO_2 capture



+ Lower efficiency penalty
+ Proven in large scale hydrogen production
+ Different products possible
- Coal gasifier is needed
- Many process steps

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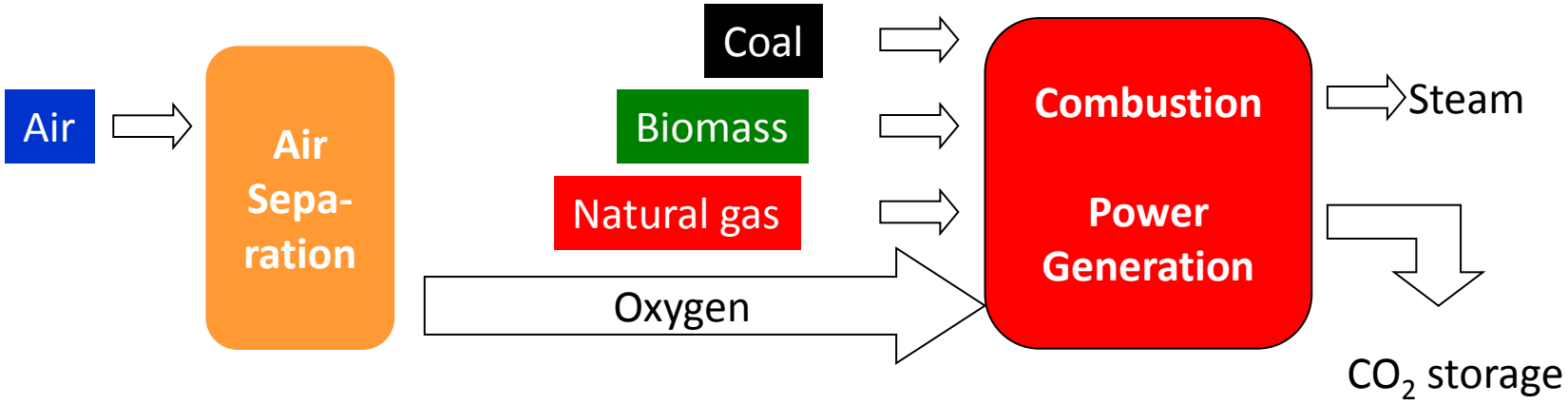
Oxyfuel CO_2 capture



+ Air separation is proven technology
- Air separation is expensive and costs energy
- Burning coal or gas in pure oxygen requires new technology

Where to store the CO_2

- Empty Oil and Gas Fields
  - Have retained oil and gas for millions of years
  - Enhanced Oil Recovery
- Saline aquifers
  - Porous rock at 1000 – 3000 m depths containing salt water
  - Closed with a cap rock

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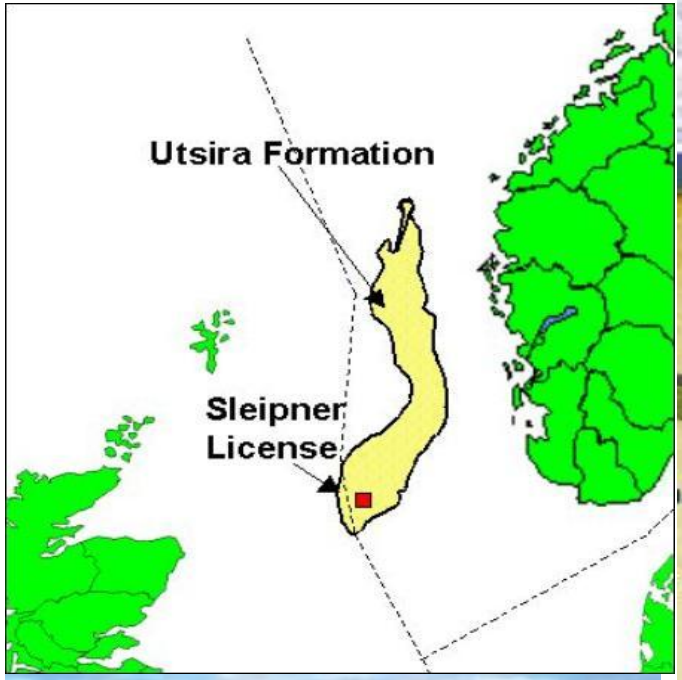
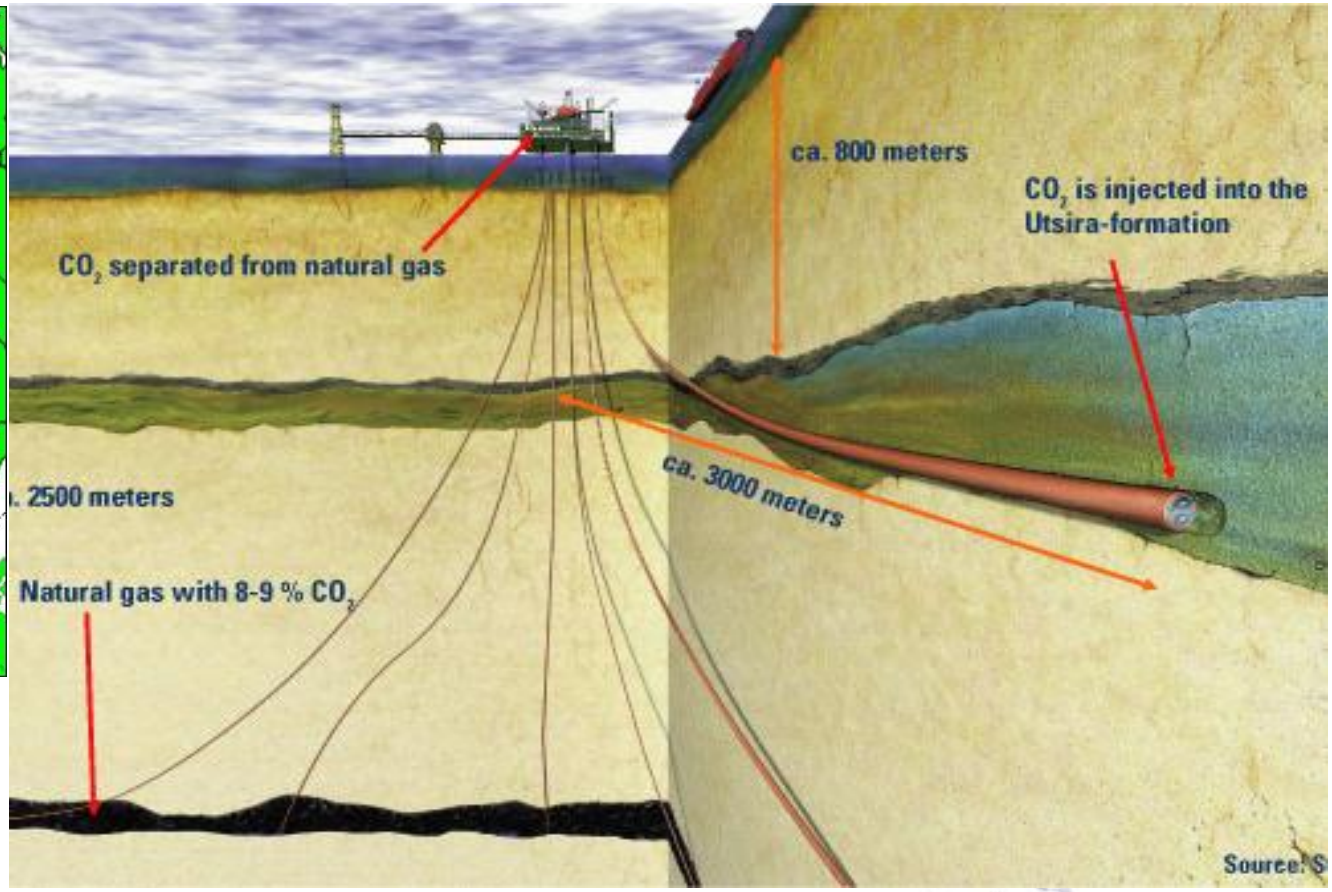
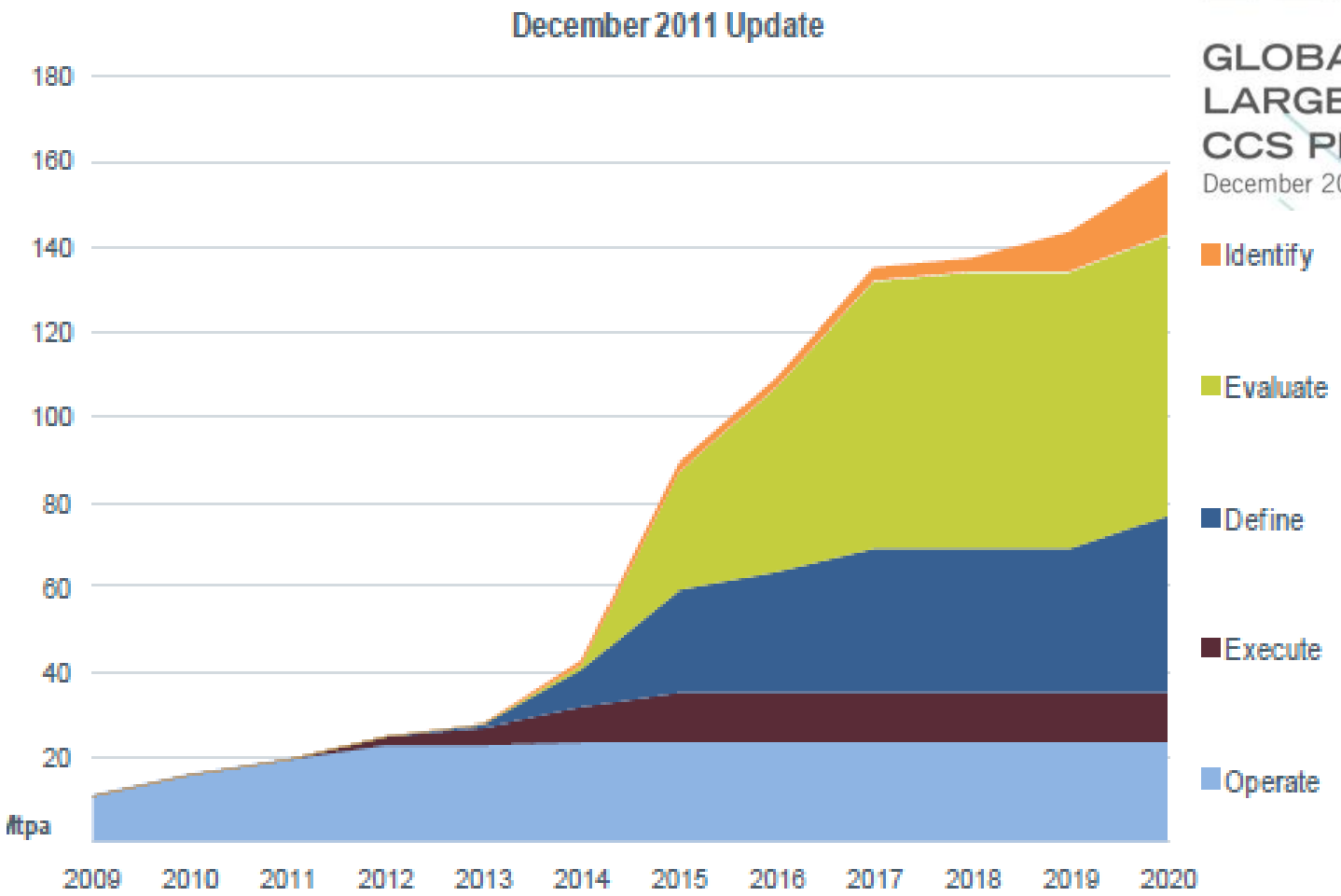
Example: Sleipner project





Current status of CCS: Large-scale CCS projects



GLOBAL CCS INSTITUTE

GLOBAL STATUS OF LARGE-SCALE INTEGRATED CCS PROJECTS

December 2011 update

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Status of CCS Demonstrations

- Major projects in the US and Norway, China starting up
- In Europe, several projects have recently been canceled
  - Although subsidies were awarded, costs were still very high
  - CO_2 prices remain low
  - Public support problems around onshore CO_2 storage
- 15 large CO_2 capture and storage projects in operation or construction
  - 35.4 million ton of CO_2 captured and stored
  - 25% increase since 2010

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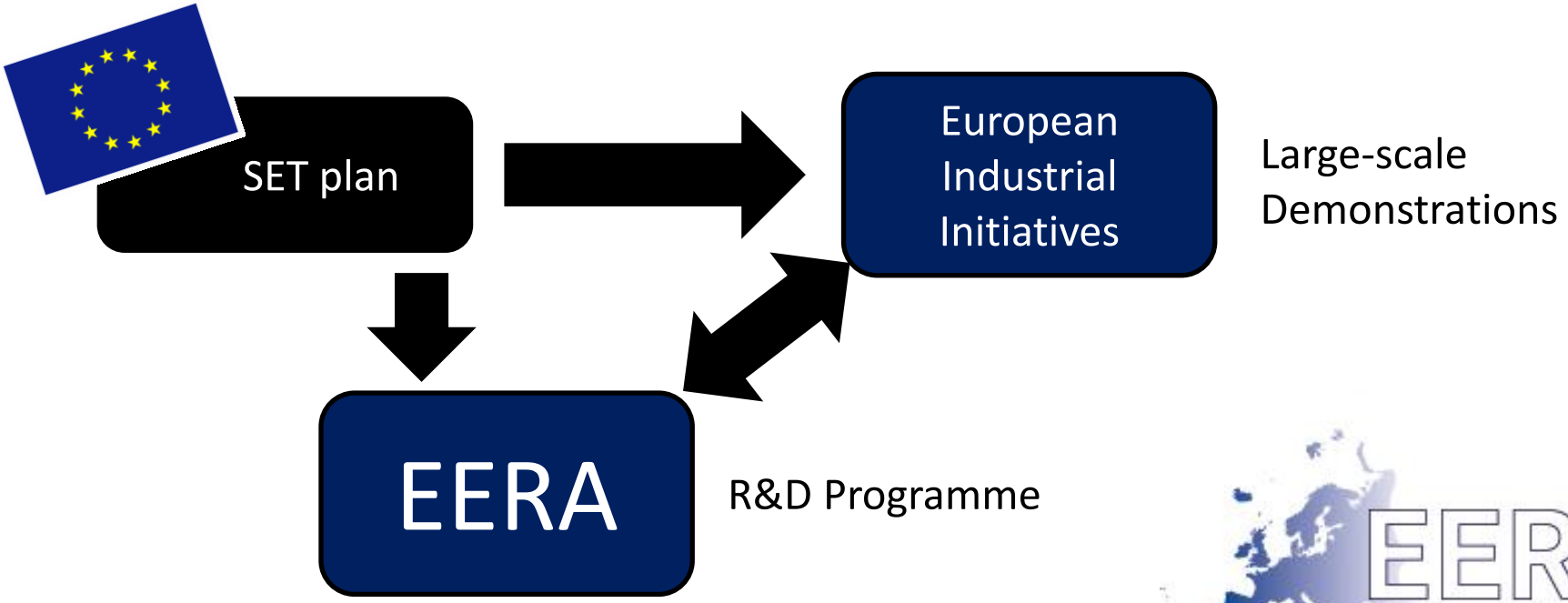
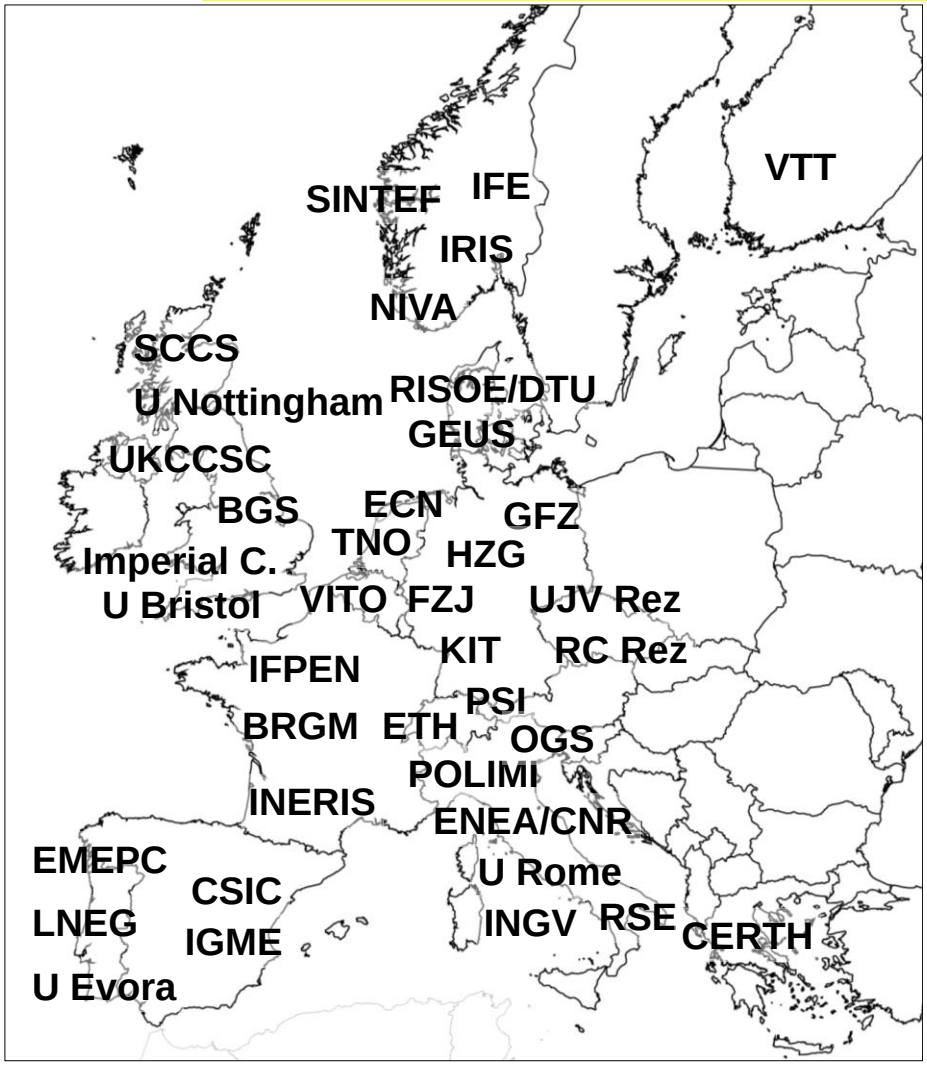
The European Energy Research Alliance

EERA general facts

- Founded in 2008 by 14 European Energy R&D institutes
- 2010: first joint programmes launched:
  - Solar PV, Wind Energy, Bioenergy, Materials for Nuclear, CCS, Geothermal, etc.



EERA Joint Programme on CCS



- Over 30 members
- 270 person years /year committed

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EERA Joint Programme on CCS

- Major goal is to develop:
  - cost competitive and energy efficient CO_2 capture methods and processes;
  - safe and reliable geological storage technologies, based on subsurface knowledge and understanding.

- Alignment of CCS R&D in Europe
  - Learning from large-scale demonstrations
  - Implementing R&D plan together with industry
  - Advising European Commission on Horizon 2020

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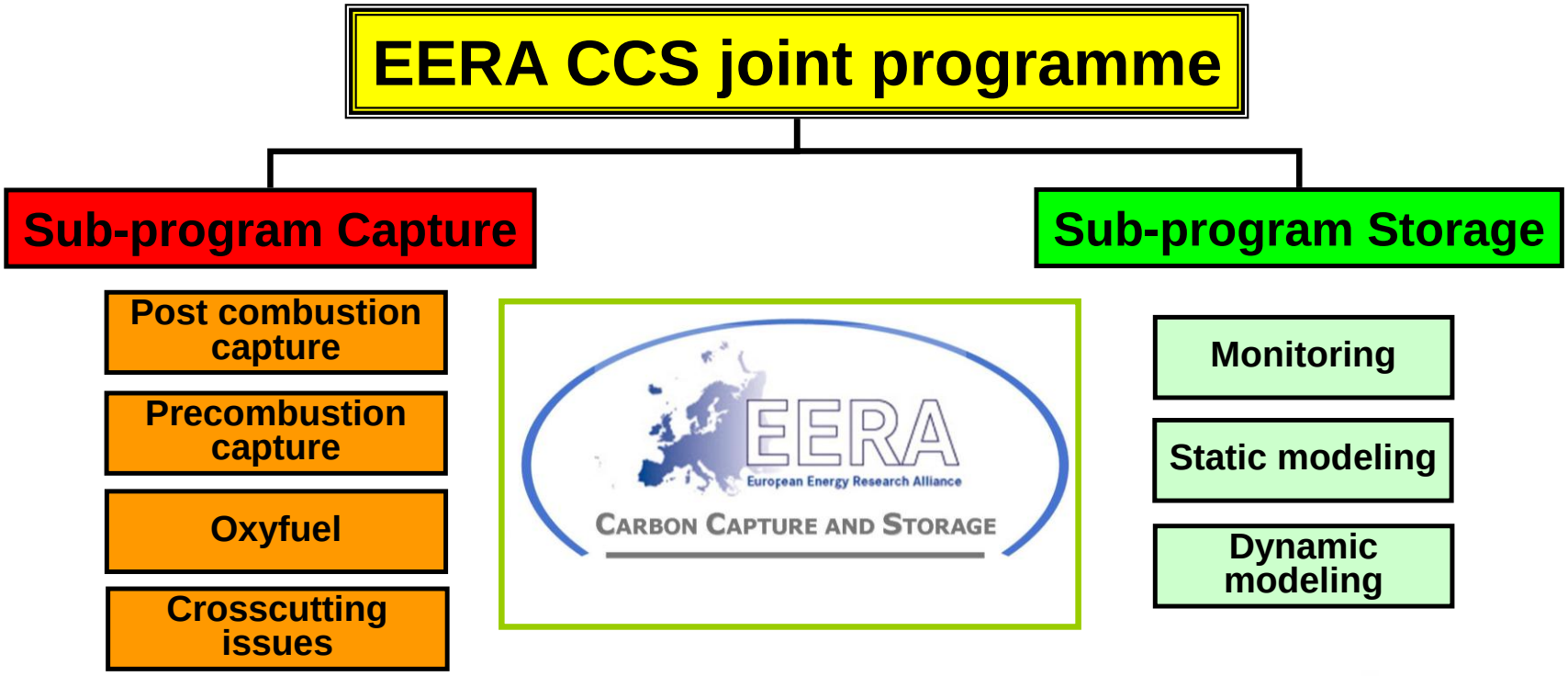
EERA Joint Programme on CCS



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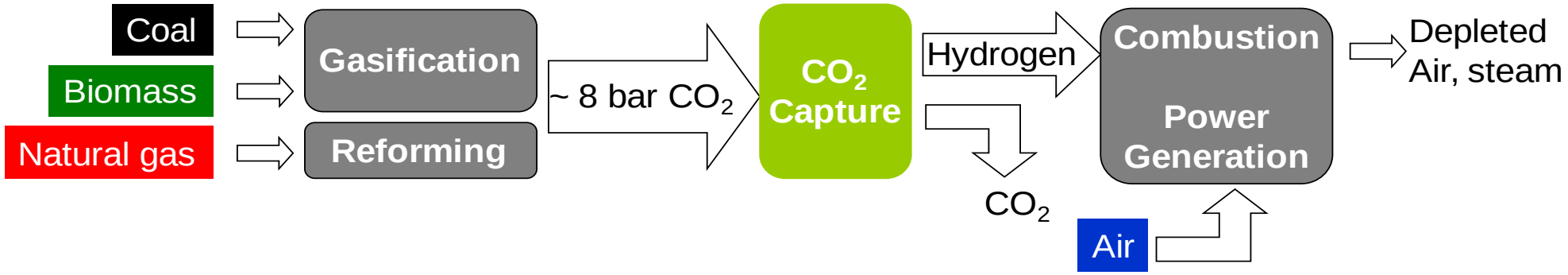
Example: Sorption-Enhanced Water Gas Shift (SEWGS)

SEWGS is a pre-combustion CO_2 capture technology



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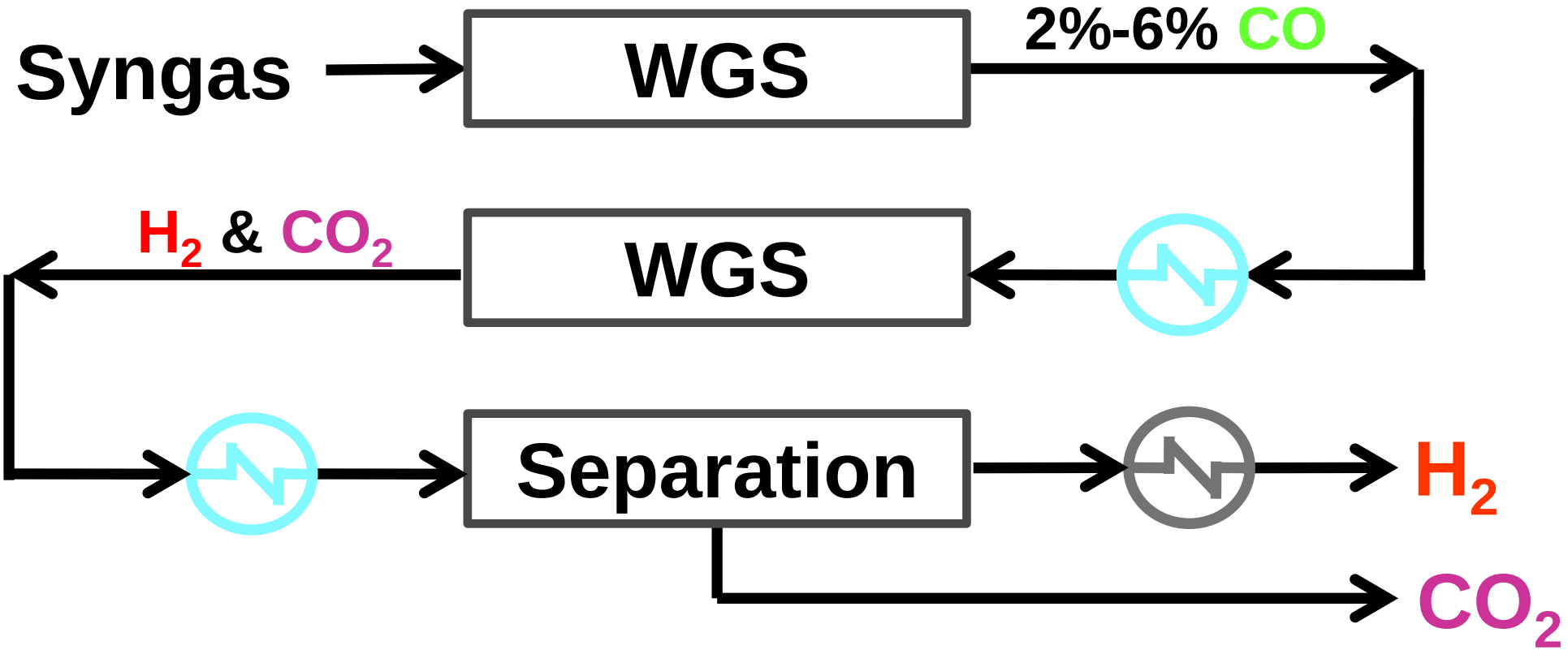
$$CO + H_2O \rightleftharpoons CO_2 + H_2$$



ECN

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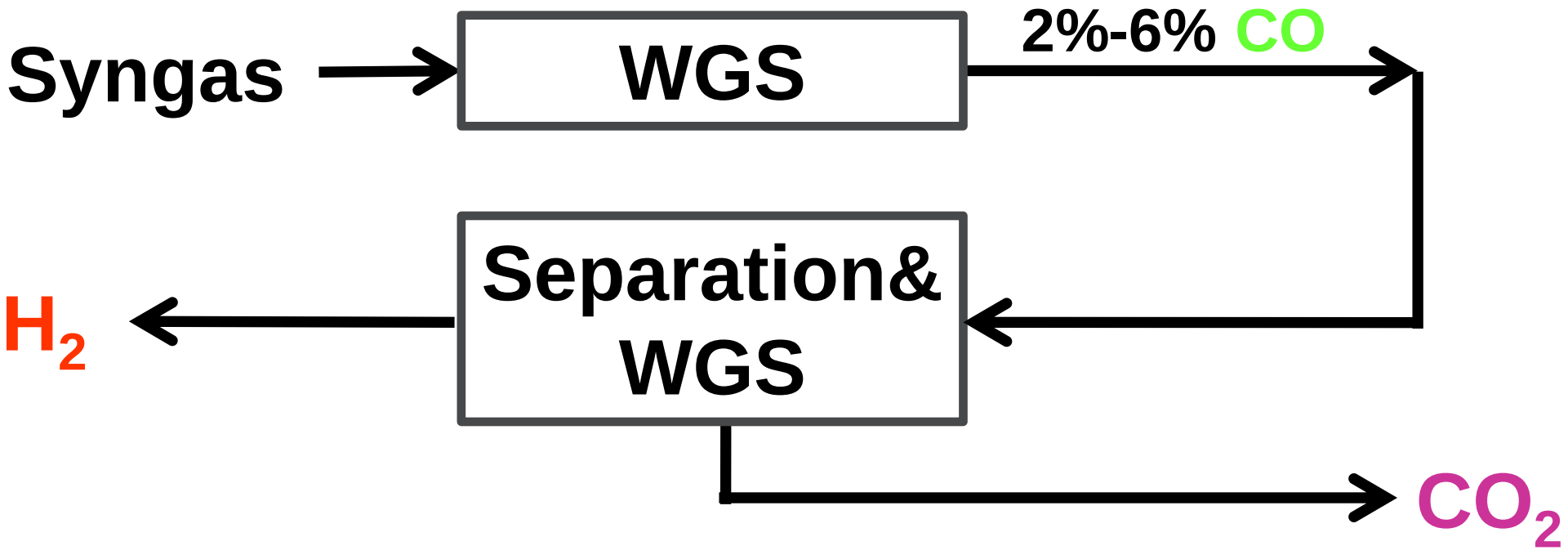

ECN

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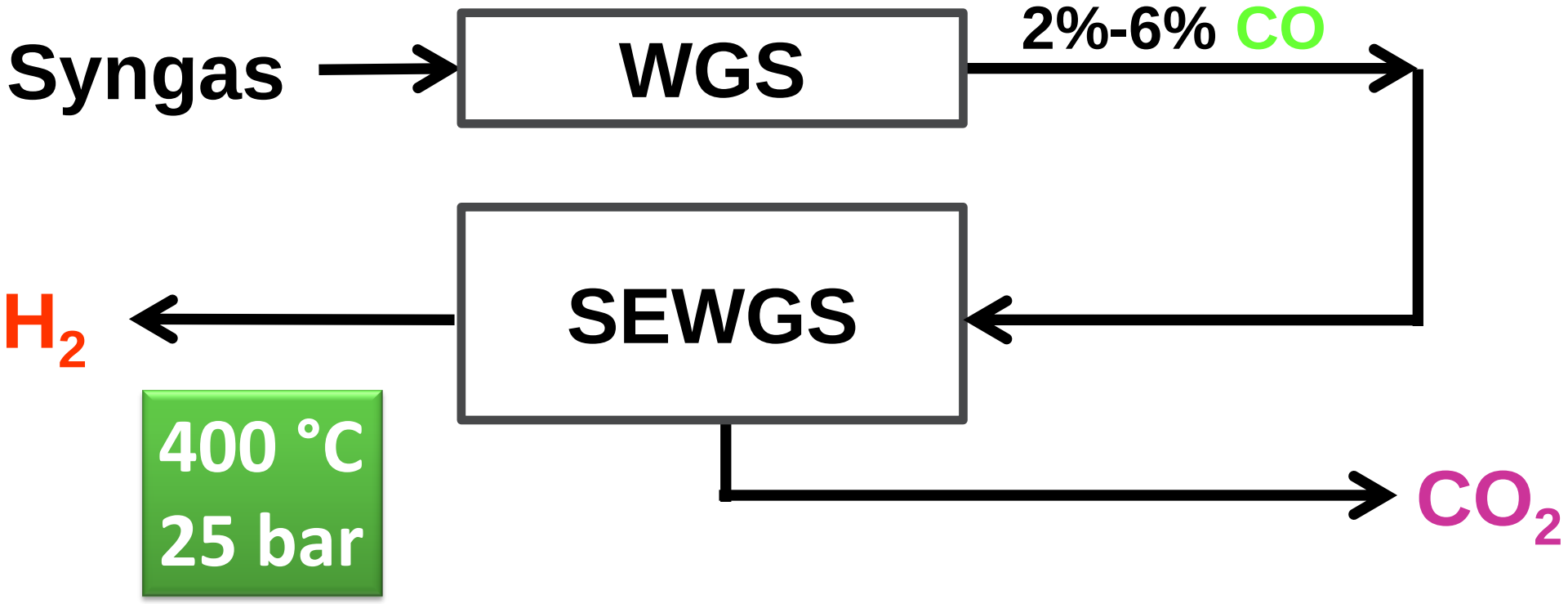
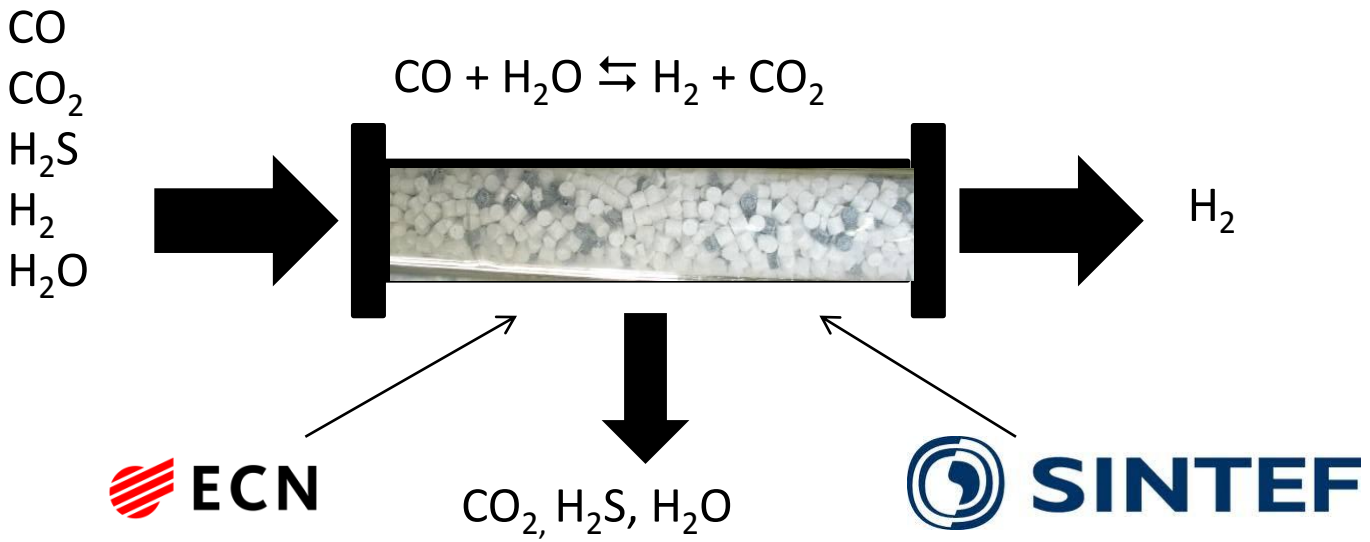
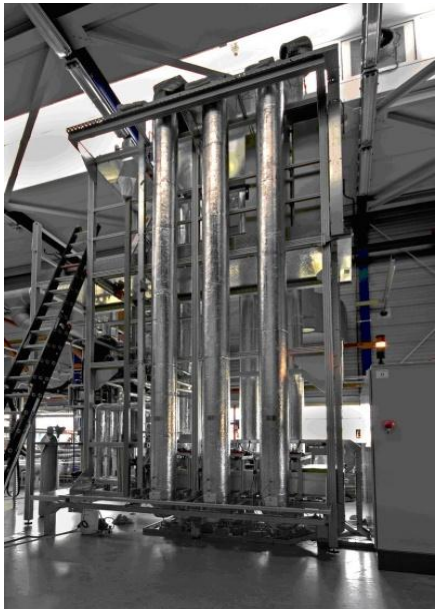


The principle: shifting and separating in a single reactor



Development status

- SEWGS process
  - Full process demonstrated on 10kWth scale for thousands of CO_2 adsorption and desorption cycles
- Stability of the CO_2 sorbent ALKASORB
  - Combined adsorbing and catalytic activity of material proven in single column rig for more than 5000 cycles using technical gasses
- Experiments showed the SEWGS process can be used in an IGCC power plant for sour water gas shift and H_2S separation



European Benchmarking Taskforce

- R&D Institutes, universities, industries
- Goal: Harmonising of technical and economic evaluations
- Makes comparison of efficiency penalties and costs of CO_2 capture between different technologies possible
- Started by three FP7 projects on CO_2 capture
- Continued in EERA

SEWGS in Integrated Gasification Combined Cycle (IGCC)

	NO CAPTURE	SELEXOL	SEWGS ALKASORB+
SEWGS CCR/CO_2 purity	-	-	95/99
Net Power Output, [MW]	425.7	383.5	404.4
Thermal Power Input$_{LHV}$, [MW]	896.5	1053.5	1018.8
Net Electric Efficiency (LHV base), [%]	47.5	36.4	39.7
CO_2 avoided, [%]	--	86.6	93,7
SPECCA [MJ_{LHV}/kg_{CO2}]	--	3.67	2.06
Specific costs, €/kW	2077.1	2854.7	2586.4
COE, [€/MWh]	65.81	88.74	81.53
Cost of CO_2 avoided [€/t_{CO2}]	--	37.9	23.3

Summary SEWGS

- Technology
  - High carbon capture ratio
  - Able to operate under sour conditions and to remove H_2S as well as CO_2
  - Combination of several process steps into one (process intensification)
  - Highest efficiencies
- Status of development
  - 0.06 tonne PDU available, performance tested
  - Catalytically active adsorbent with proven long term stability and functionality
- Further R&D: part of EERA programme
  - Developing application in blast furnace gas, hydrogen production
  - Proving new sorbent on pilot scale

Final remarks EERA CCS JP

- CCS
  - Large-scale demonstrations coming off the ground
  - R&D for cost reduction and trust in storage is still necessary: **EERA**
- Large group of R&D institutes assembled
  - Alignment of R&D programmes
  - Common R&D, use of facilities: **focus workshops**
  - Benchmarking taskforce
- Future of EERA
  - Role in Horizon 2020
  - Funding

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