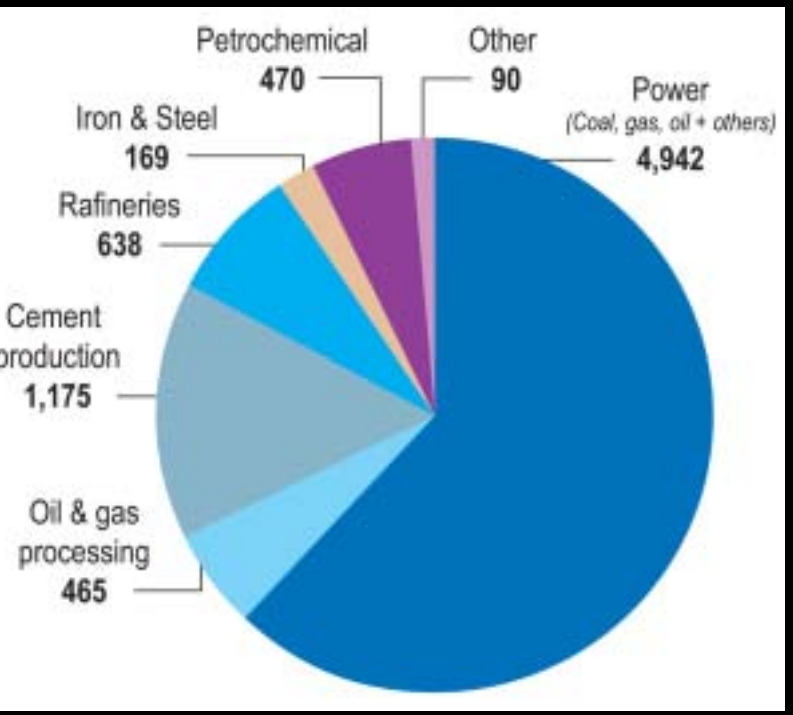
挪威环境技术创新模式案例分析

贾峰

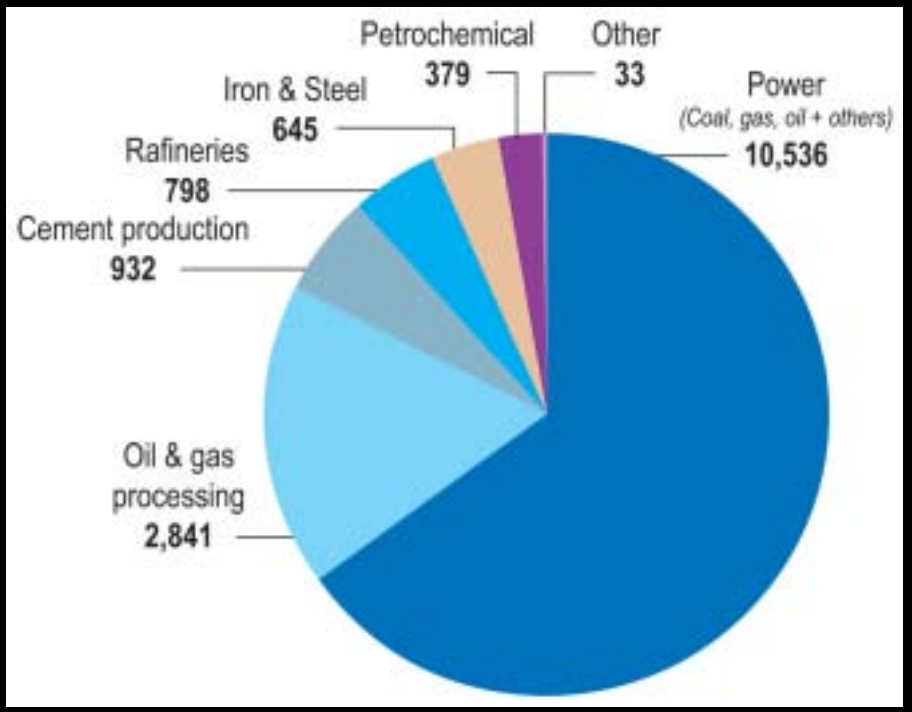
2008年2月28日

Global stationary sources of CO_2

Number of Facilities: 7949

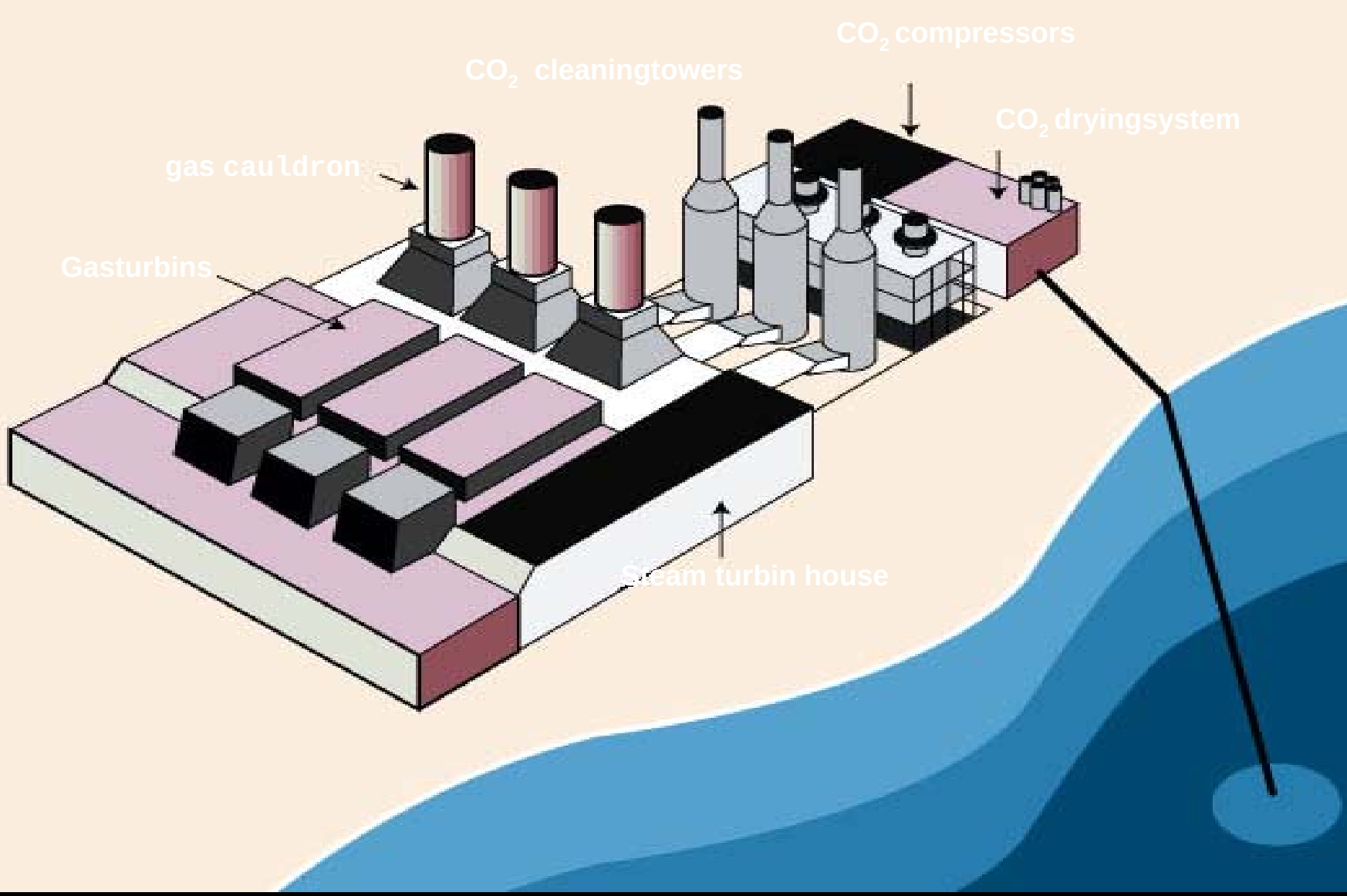


Total 16164 Mt CO_2/yr:

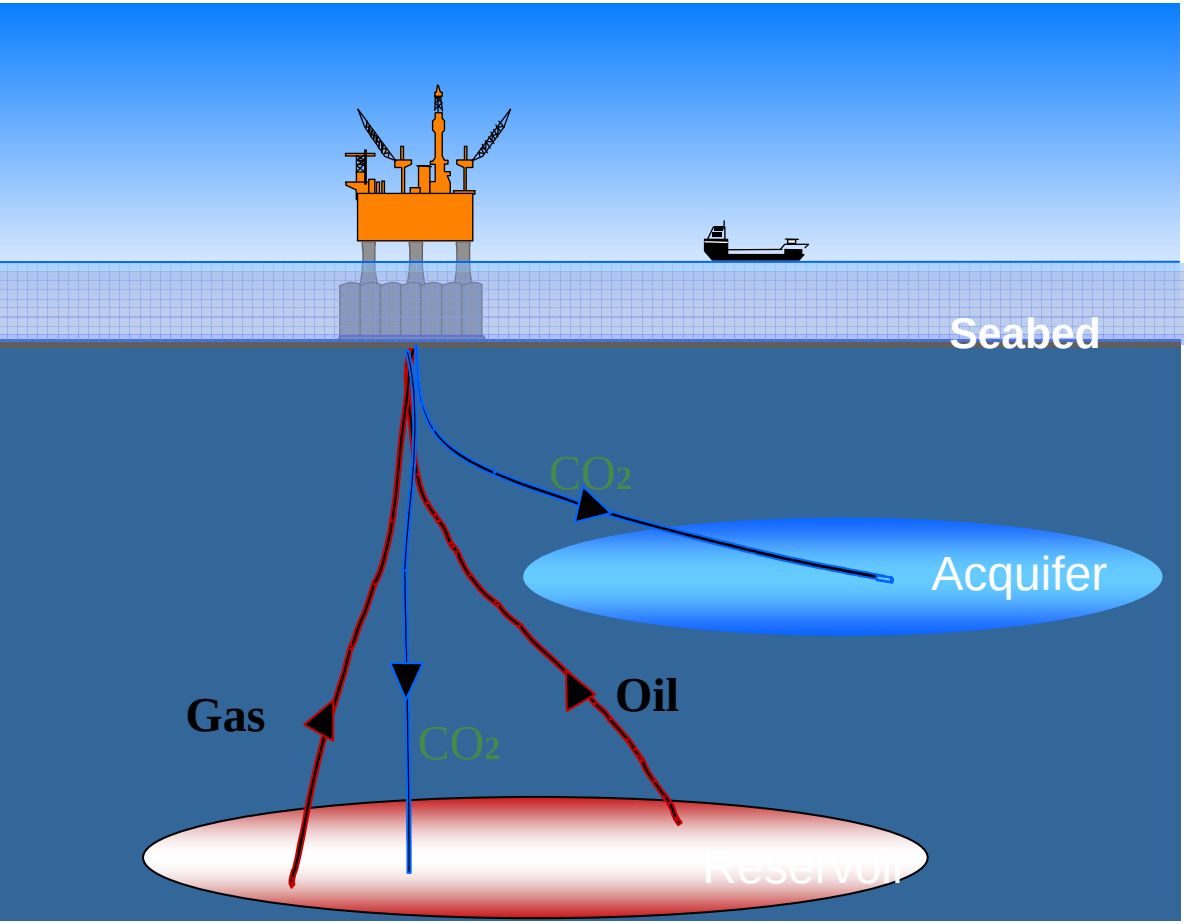


- **Global emission :CO2/yr: 24 000 Mt**
- **Stationary sources: CO2/yr 16100 Mt**
- **Number of Facilities: 8000**
- **Average emission from each facility: 2 Mt**
- **Stationary sources more than 60 % of all CO2 emissions**

Source: IPCC, 2005


CO_2 compressors
CO_2 cleaningtowers
CO_2 dryingsystem
gas cauldron
Gasturbins
Steam turbin house

CO_2 Capture and Storage

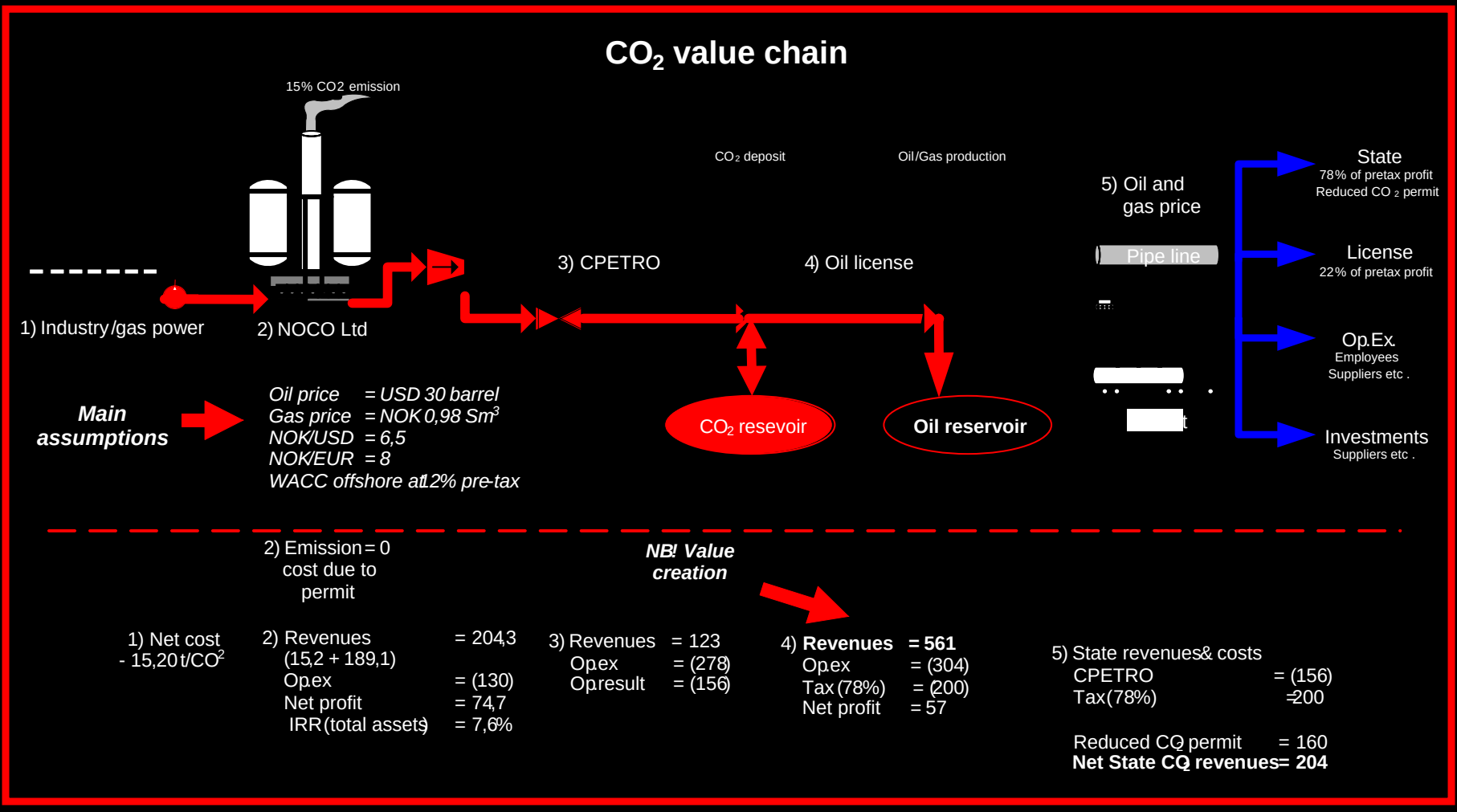


North Sea:

500 bill. ton CO_2 storage capacity

Huge potential for Enhanced Oil Recovery

The CO_2 value chain



Norwegian CO_2 challenges & opportunities

Kårstø

3 large CO_2 capture projects in development.

Mongstad

Halten

European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP)

Vision statement:

To enable European fossil fuel power plants to have Zero Emission of CO2 by 2020!

and

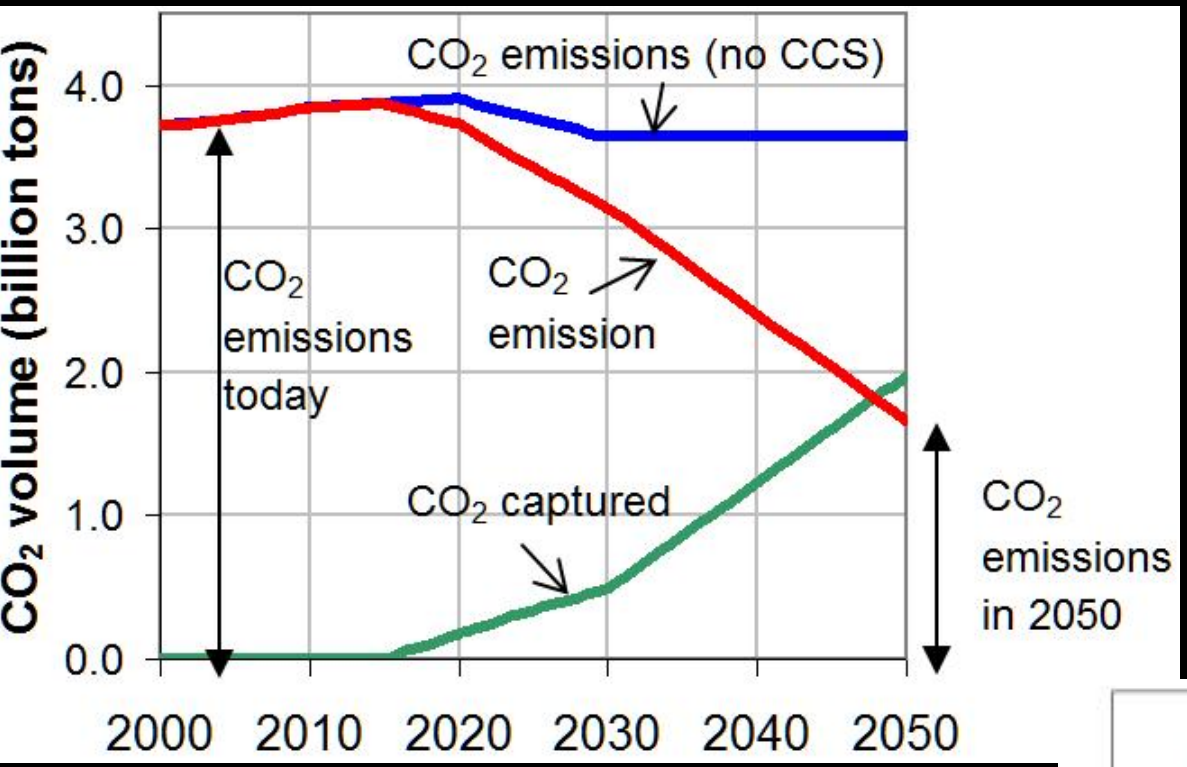
Capture 30 Giga tons CO_2 before 2050

EU Technology Platform ZEP (Zero Emission Fossil Fuel Power Plants)

Siemens, Bellona, BP, Statoil,
Shell, ENEL, RWE, Eon,
Vattenfall, Endesa, EDF, Ansaldo Energia,
Schlumberger, Air Liquide, Total, Foster Wheeler,
CMI, Mitsui Babcock, Energi E2, IPF,
CIRCE, British Geological Survey,
Geological Survey of Denmark and Greenland,
WWF, Alstom.

Advisory Council for European Commission

Potential for CO_2 Capture in the EU



CO_2 emissions in 2050 reduced by

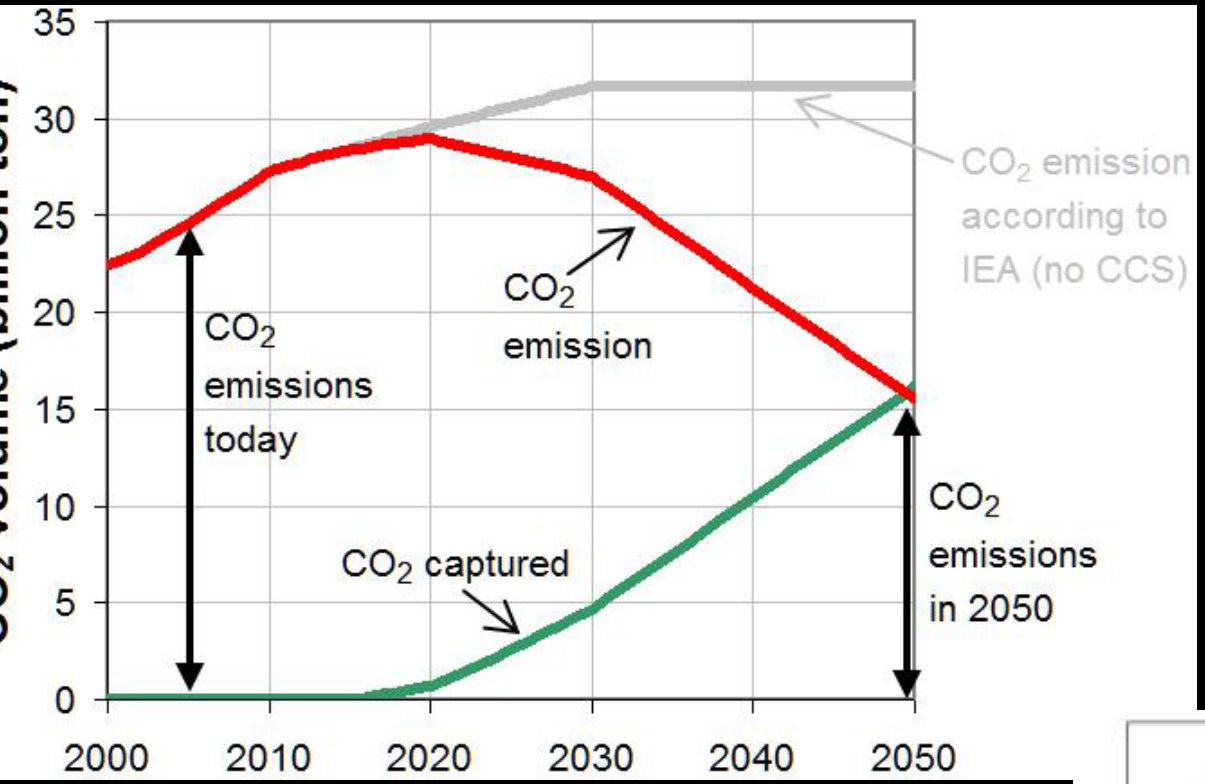
56 %

Compared to emissions today

Z E P

Zero Emission Fossil Fuel Power Plants

Globally CO_2 Capture Potential



CO_2 emissions in 2050 reduced by

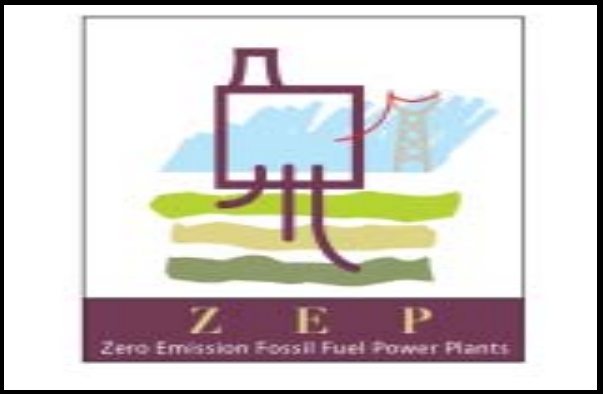
37 %

compared to emissions today

Z E P

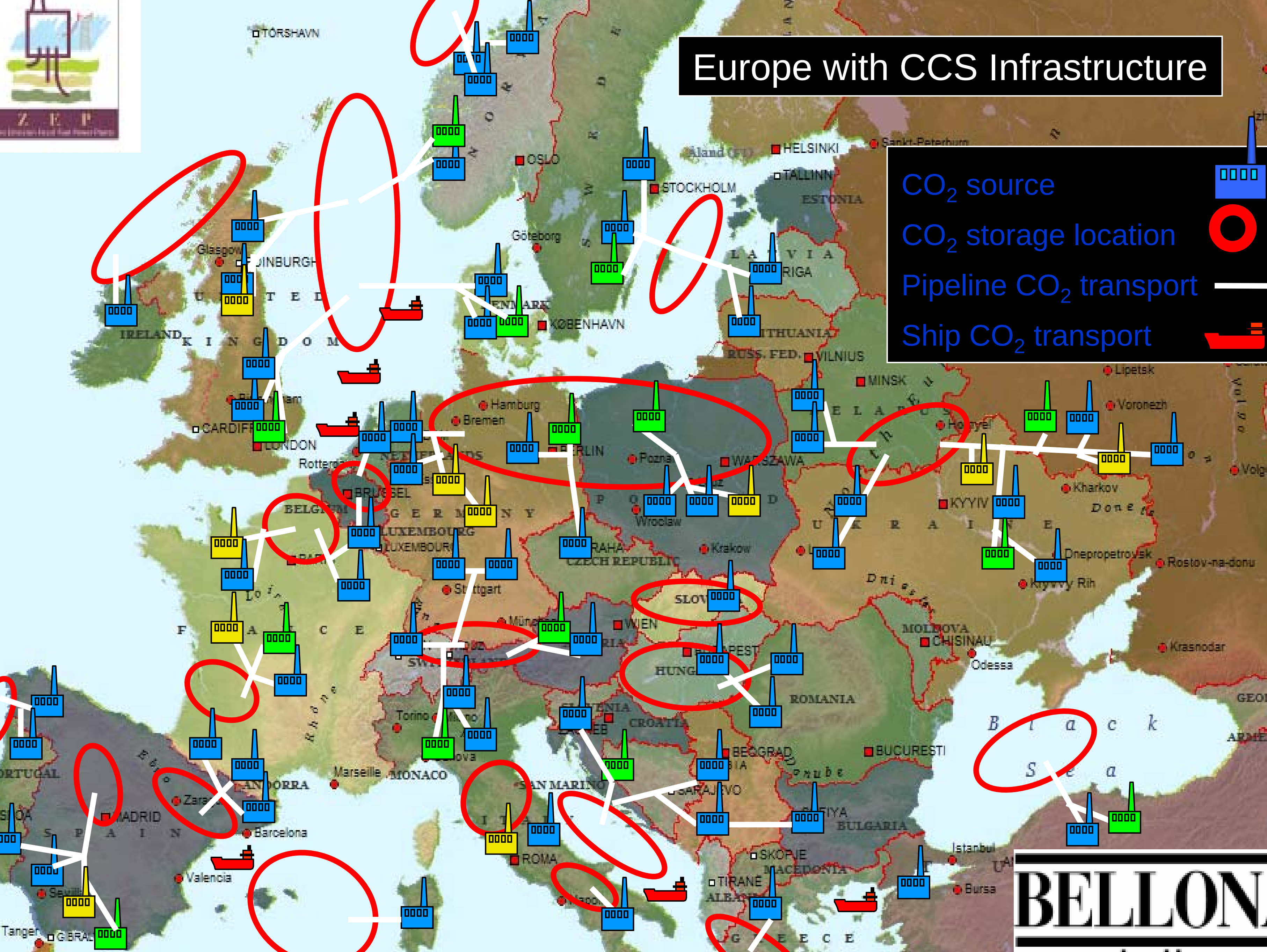
Zero Emission Fossil Fuel Power Plants

The European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP)



ZEP mission:

- ***To enable European fossil fuel power plants to have zero CO_2 emissions by 2020***
- ***To establish a Flagship programme for 10-12 CCS projects in Europe***
- ***To establish framework and regulations for CCS***


Europe with CCS Infrastructure
CO_2 source
CO_2 storage location
Pipeline CO_2 transport
Ship CO_2 transport

Technologies where CCS is relevant

- CO_2 capture from power production, natural gas, coal, petrochemical plants, cement production, iron production
- Production of H_2 for power production and transport
- Deep coal reservoirs that are unmineable today
- Low pressure gas
- Source with to high CO_2 content for fiscal sale
- Biomass

Comment and analysis

Give carbon a decent buria

Most green groups are against it, but burying carbon dioxide under the sea is vital if we are to halt global warming, argue **Frederic Hauge** and **Marius Ho**

SWEEPING things under the carpet can be a bad idea. But what do you do when the floor is so thick with dust that any reduction would be an improvement! Swap dust on the floor for carbon dioxide in the air, and the carpet for the seabed, and that's a dilemma world governments now face.

In other words, as an interim measure until renewable energy replaces fossil fuels, should we start soaking up CO_2 from fossil-fuel power stations, the largest producers of CO_2, and bury it where it can't contribute to global warming? Given that the alternative means allowing climate

"If storage sites are selected carefully they could retain CO_2 over a geological timescale"

attention away from dealing with the root of the problem: our contin dependence on fossil fuels. Green groups also worry that leaks from burial sites could damage marine l

Though these concerns are honourable, we are convinced they misplaced. Tests to date indicate th there is little chance the gas would leak or escape. Natural hydrocarbo have stayed trapped in sedimentary basins for millions of years, and if storage sites are selected carefully could reasonably be expected to re CO_2 over a geological timescale. For example, in the Pagah anticline north-east of Jackson Dome, Mississippi, 200 million tonnes of is thought to have been trapped underground for over 65 million ye

In the North Sea, the Norwegian company Statoil is already burying Natural gas from the Sleipner offsh field contains more CO_2 than is allo in the gas distribution system, so St has to separate out the excess. Inste of releasing it into the atmosphere, Statoil pumps it back offshore where is injected into the saline Utsira aqui 1000 metres below the seabed, und a layer of impermeable shale. Since t process began in 1996, about 1 milli tonnes of CO_2 have been injected int the reservoir every year, equivalent to 3 per cent of Norway's CO_2 emissio The alternative would also have cost Statoil dear in CO_2 emission taxes.

A seismic survey in 2002 by the British Geological Survey showed that the CO_2 was forming a bubble metres in diameter at the top of the

Coal and CO_2 capture

Why coal combined with CCS:

High CO_2 content in flue gas from coal power plants

Coal gasification for H_2 production

CO_2 injection in deep mines to produce methane

Co-firing with 20 - 90 % biomass

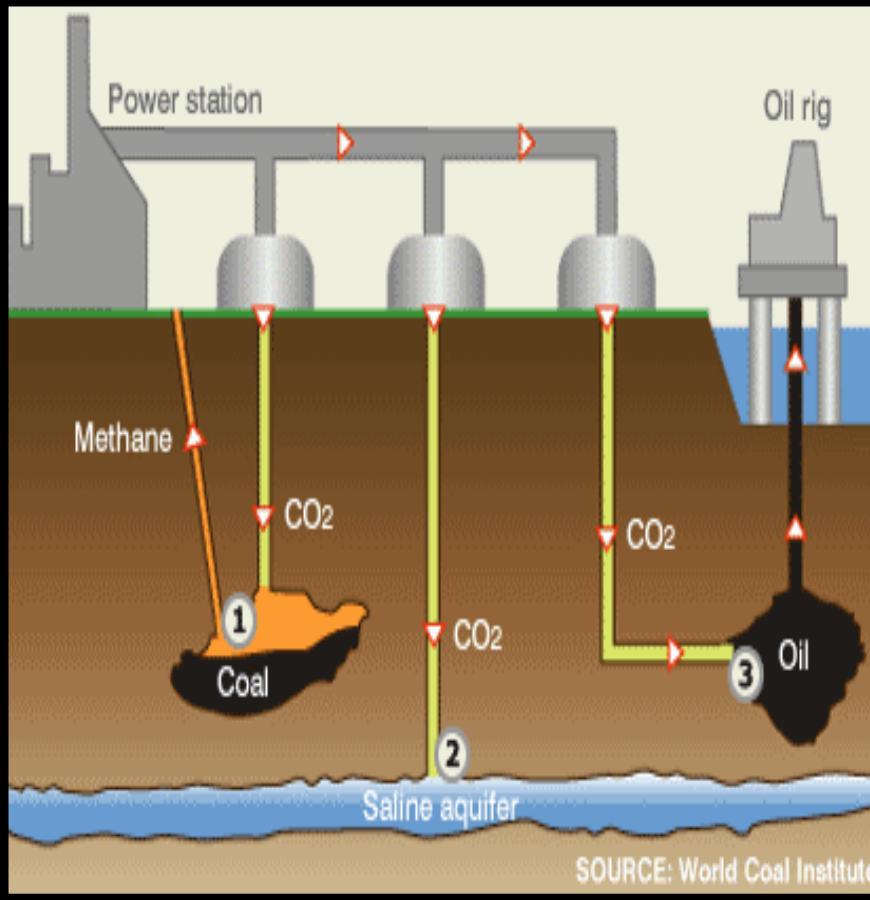


Fig: Bio/Coal power plant

CO_2 capture and H_2 production

H_2 can be produced from steam reforming of low pressure methane gas:

Stranded gas

- Gasification of coal
- Injection of CO_2 to recover methane from deep coal mines
- Biogas

CO_2 from H_2 production can be captured and stored

Bio energy and CO_2 capture

- Bio energy is CO_2 neutral
- Coal power plants can be fired with a mix of coal and biomass
- Power plants fired biomass
- Biomass can be used for production of methane or hydrogen
- Biofuel should be produced with CCS
- CO_2 capture and storage from biomass will give net reduction of CO_2 in the atmosphere

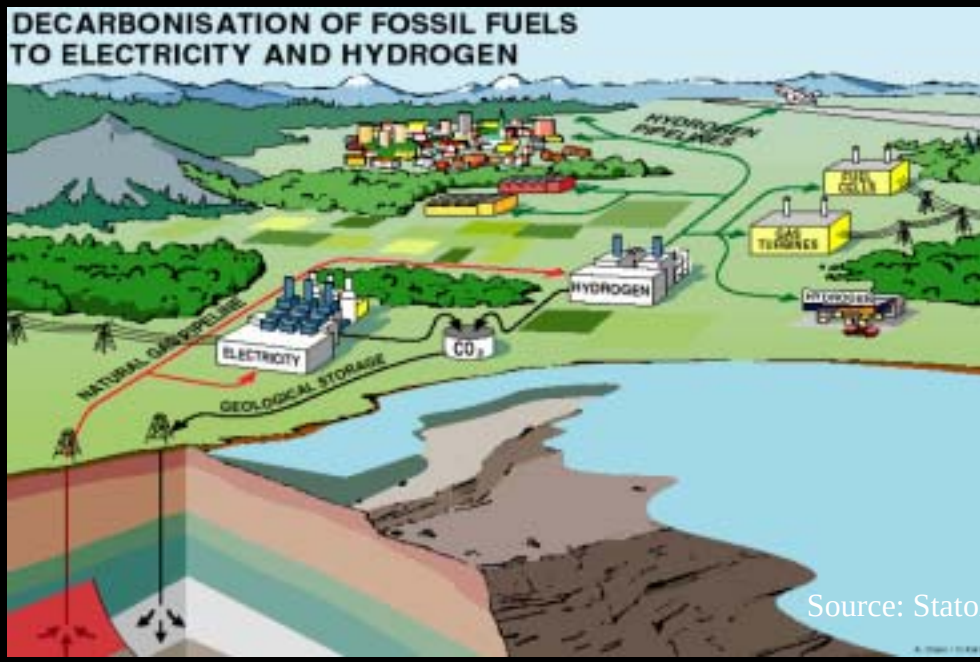
Technologies where CCS is relevant

- High temperature fuel cells based on hydrogen or methane is the most effective power production
- Will also be used in maritime sector
- Low temperature fuel cells for onshore transport. More than twice the efficiency of traditional engines
- Fuel cells based on hydrogen from on steam-reformed biogas, stranded gas and gas from coal
- Hydrogen can be produced with CCS technology

Putting Out the Fire - Benefits

- Chinese and global CO_2 emissions considerably reduced
- Loss in coal reserves stopped
- Economical gains
- Introduce CCS in China

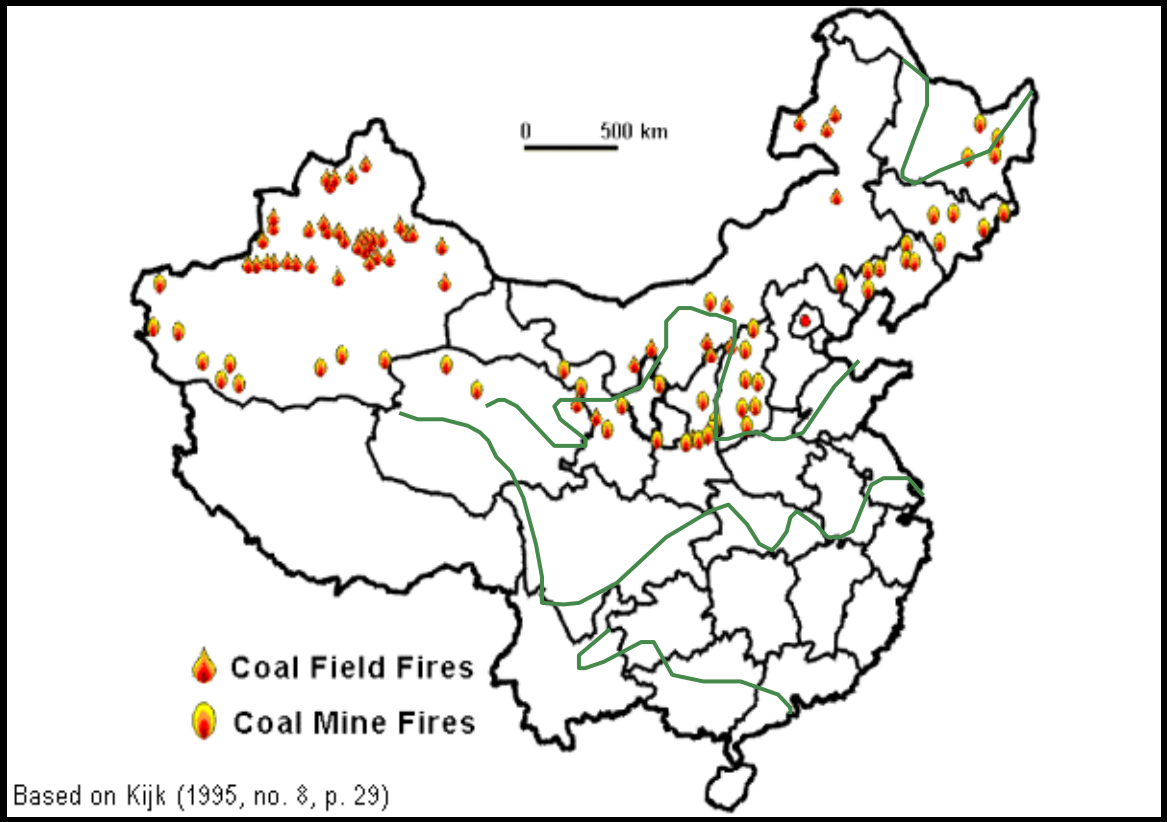

Source: ITC



Source: Stato

Coal Fires and CO_2 Emissions

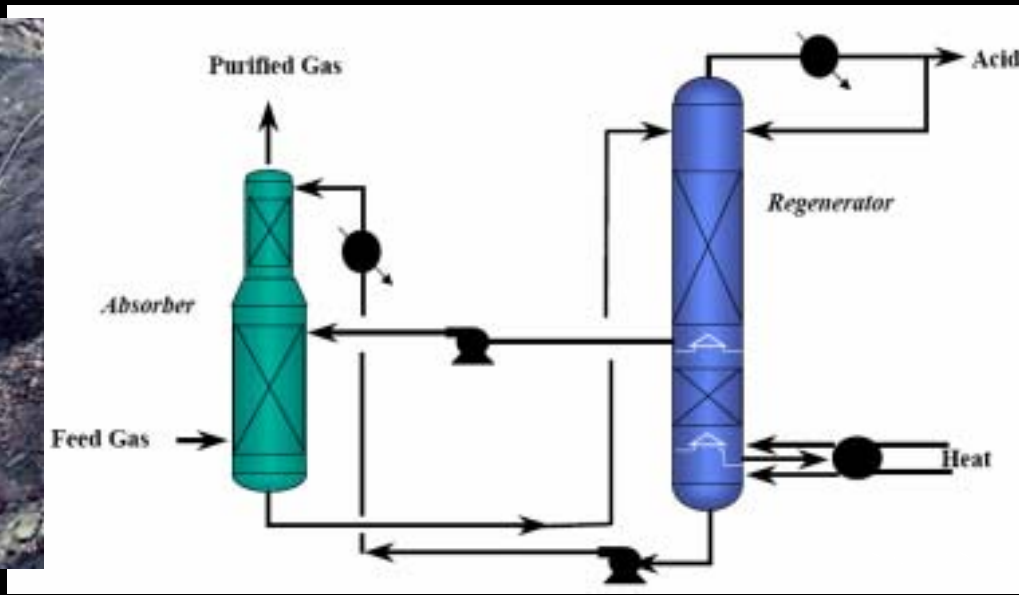
- 100-200 million ton coal lost annually due to coal fires in China
- 2-3 % of global CO_2 emissions



Putting out the fire in coal mines with CCS

- CO_2 capture technology can extinguish coal fires
- Sargas technology is applicable

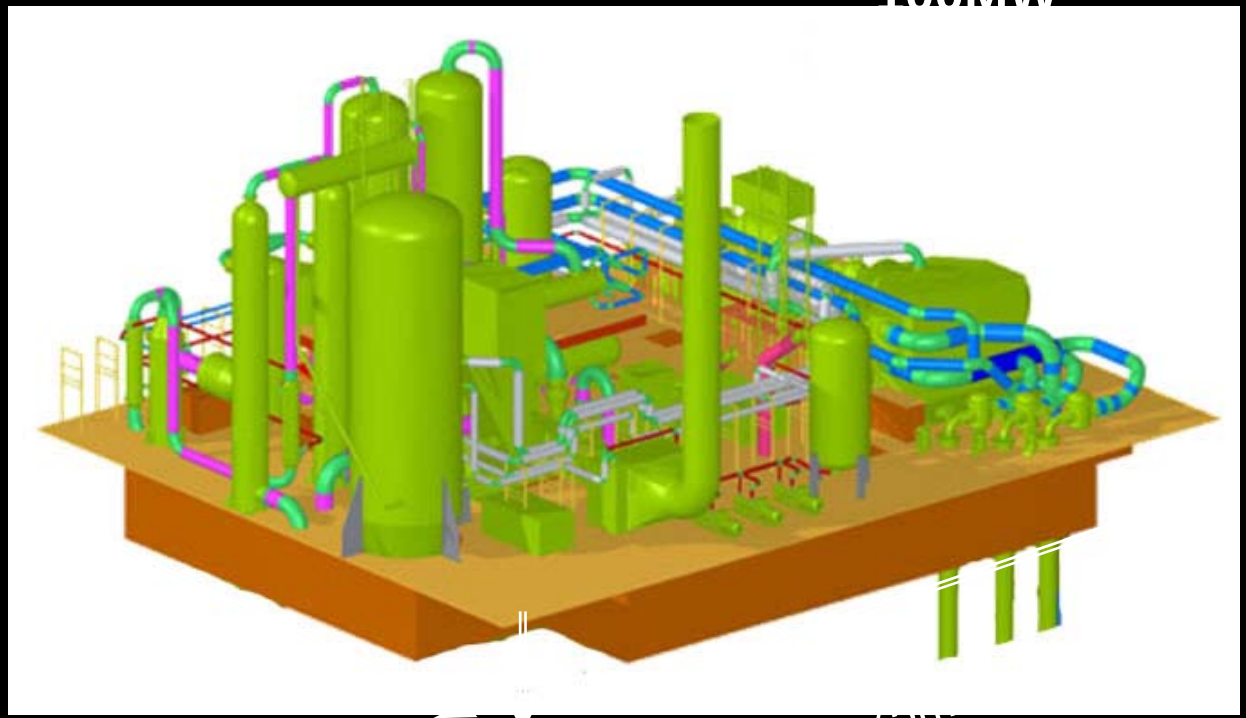
Old method: Removal of hot or combustible coal



New method: The Sargas technology produces CO_2 which can be used to put out coal mine fires

SARGAS
Clean Power Solutions. Now.

Barge Mounted Power Plant – 100MW



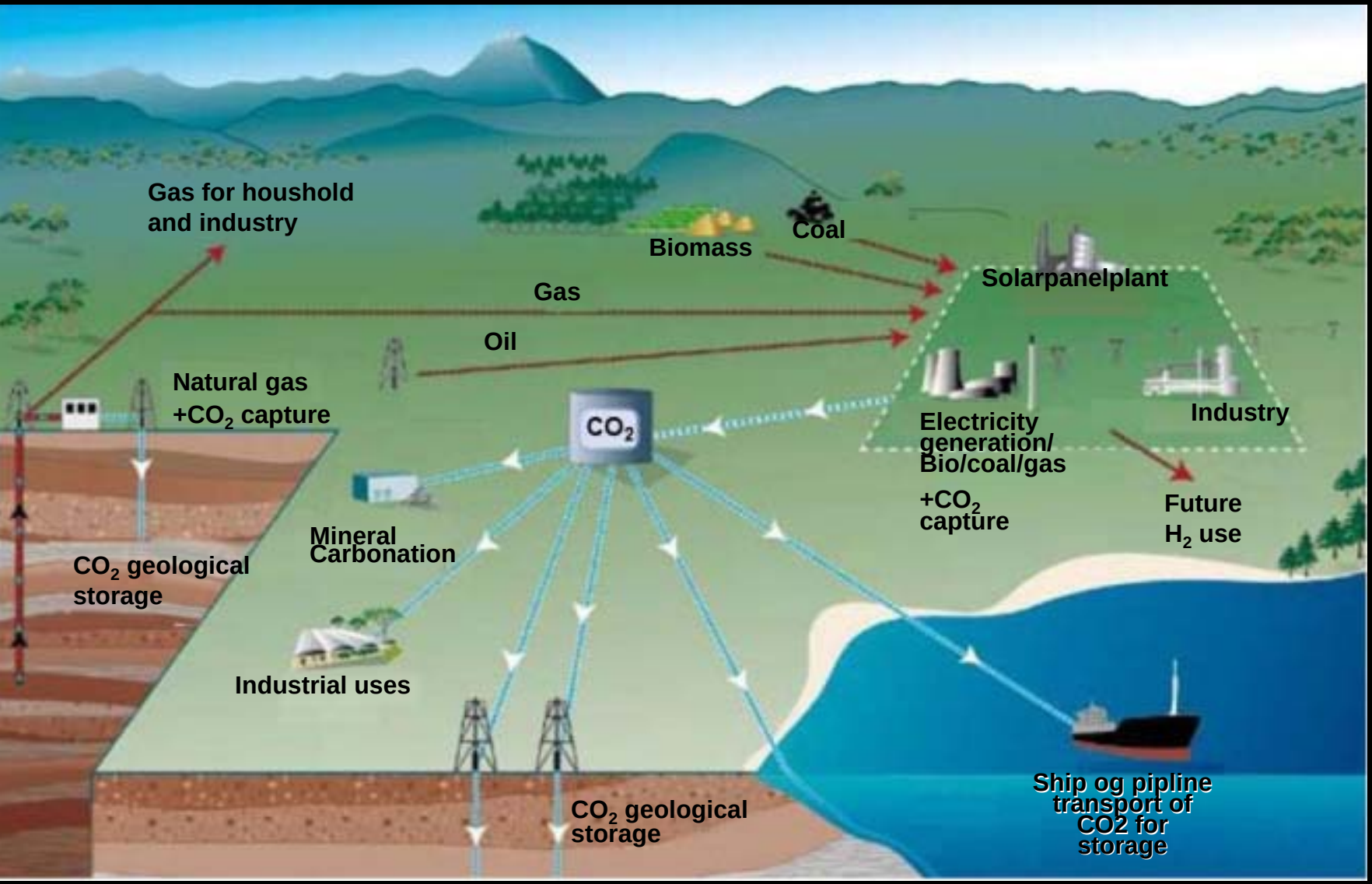
5000 t

Captured CO_2 used as extinguishing gas to coal mine fires

– 2 200 tons /day.

Bellona Foundation and Sargas search partners in China for common future studies of using carbon capture technologie to put out coal mine fires.

CCS infrastructure - CO_2 capture, transport and storage



Kilde: CO2CRC and IPCC

Värtan Stockholm

SARGAS
Clean Power Solutions. Now.

Sargas demo plant

Purpose:

1. Demonstrate CO_2 capture from a coal fired power plant.

2. Demonstrate cleaning of flue-gas and process to avoid settlement of particles

3. Process fine-tuning for modular fabrication on global scale

Q4 2007 at Värtan, Stockholm

Fortum

SARGAS
Clean Power Solutions. Now.

Contributors

Alstom

Royal Institute of Technology
Stockholm

Siemens Power AG

Reaction Systems Engineerin
Boston

Institute for Energy Technolo
Kjeller

PsiPro Kristiansand

400 MW Clean Coal power plant

At Husnes, Norway

Investment Decision 2008
= Ready 2011

- 4x100 MW Coal fired with CO2-capture
- Location: Next to SørAl Aluminum Work
- Industrial Ownership :
  - SørAl 50/50 Alcan-Hydro Aluminium
  - Eramet Norway
  - Tinfos Group
  - Sargas
- Target COE 6 US cents/kwh –incl. captur
- Output per annum:
  - 3,000 GWh Electricity
  - 2.5 mill. ton CO_2

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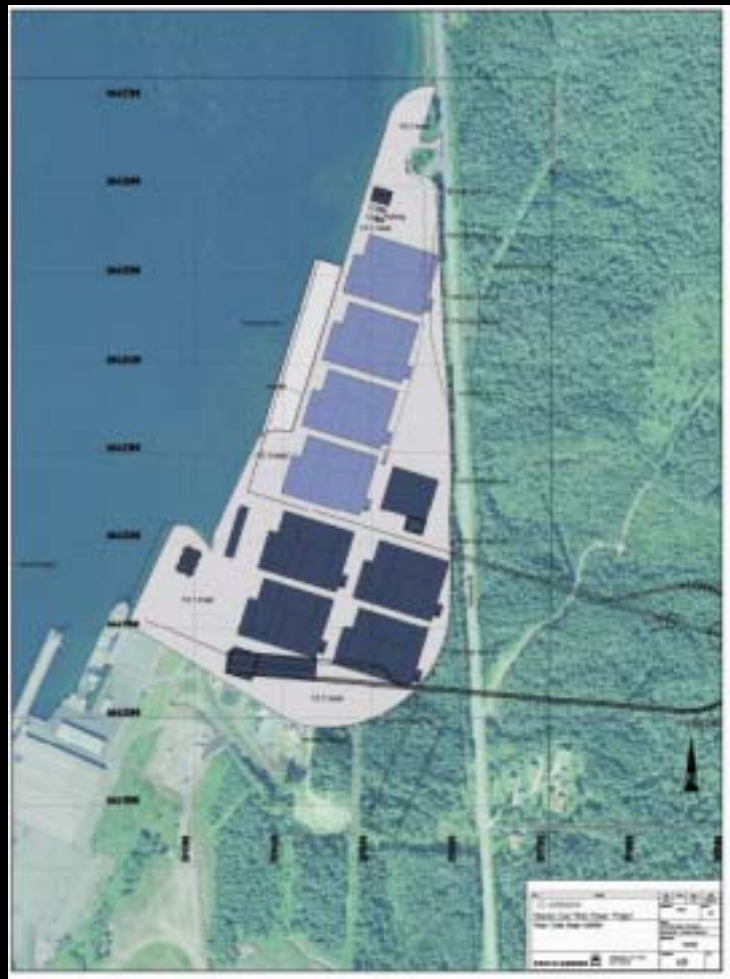
400 MW Clean Coal power plant at Husnes

- **Prelim.layout :**
  - **4 x 100 MW Step One**
  - **Further 4 x 100 MW in Step Two**
  - **5 mill tons CO2 p.a after Step Two**



De mørke modulene viser det planlagte kraftverket. De lyse illustrerer en mulig utvid

SARGAS
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400 MW Clean Coal power plant at Husnes

- **Layout includes underground coal storage facility and Dust free ship-to-shore discharge system**

Zero Emission Power off shore – TRIPP EL

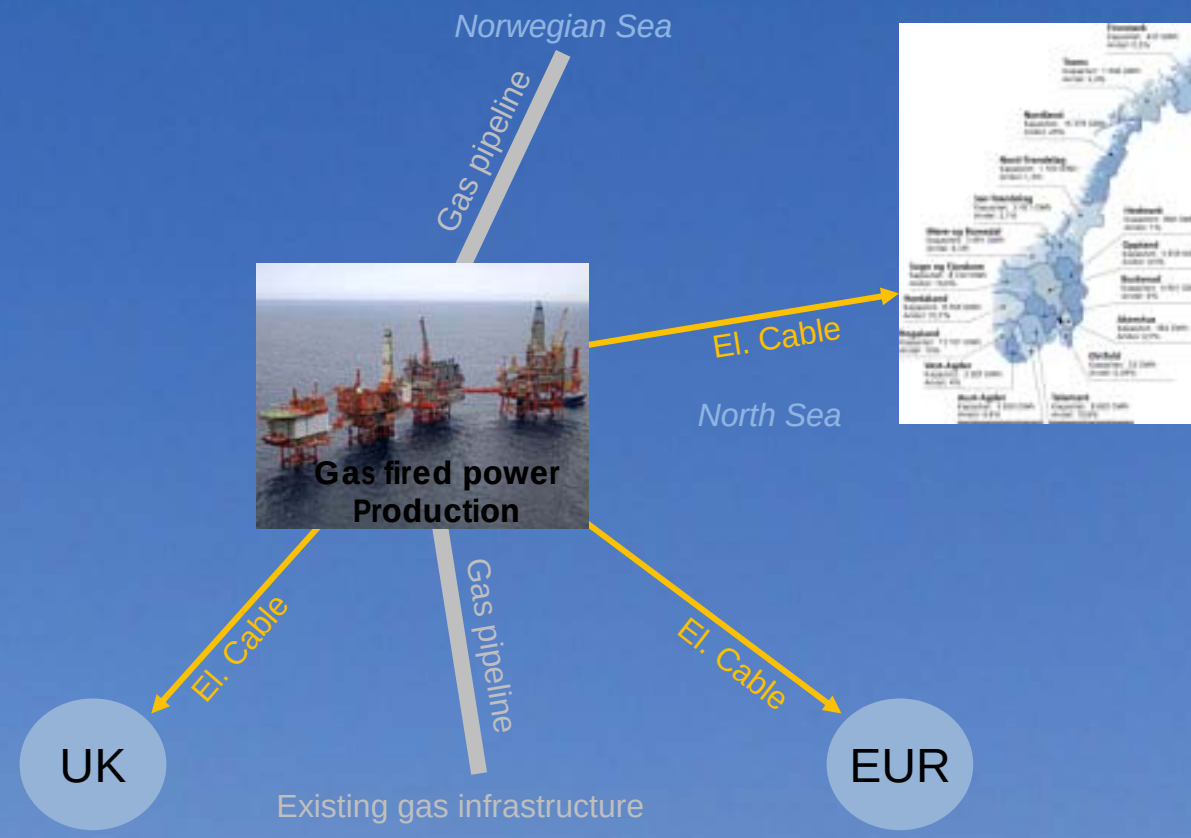
Off shore units re-powered with 95 % CO_2 captured

Compact plant;
200 MW = 11 000 tons load

New Energy supplied to N, UK and EUR

CO2 used for EOR and later deposit

Increased oil production, and longer field life



Green Tanker

CO_2 from Värtan to Sleipner