

CCS Talk in 2010

With recent comment 30th Jan 2021

This is a pdf of a talk I was asked to give at Edinburgh Napier University in June 2010 to a local energy group

They wanted someone would put the case against CCS (Carbon Capture and Storage), as the prevailing opinion was that this is the way to go.

My own cynical view was that CCS, with its focus on capturing the CO₂ from coal and gas fuelled power stations, was an expensive research project going nowhere. It was kept alive as it allowed politically minded civil servant and power plant operators to continue to produce power in the same old way.

If we were really keen about CCS, we would be building IGCC (Integrated Gasification Combined Cycle) plants, in which 100% CO₂ was easy to capture.

There was a lecture in opposition to what I was saying, all about global warming. In response I made it clear that I accepted it was a real issue but I thought that wind power was the best and quickest way of meeting this problems.

Since I gave the talk, over ten years ago, not one CCS plant has been built in Britain or in Europe. Peak wind power in 2010 was about 1.7 GW. In 2010 it was over 13.0 GW. All power plant coal mines have been closed and the few power stations that remain are off most of the time and rarely produce more that 5% of the demand

An aerial photograph of a large industrial complex, likely a power plant or refinery, featuring numerous tall smokestacks, large storage tanks, and various industrial buildings. The image is slightly grainy and has a greenish tint.

Carbon Capture and Storage *in the UK*

Questions that Need to Be Asked

Fred Starr
Materials and Energy Consultant

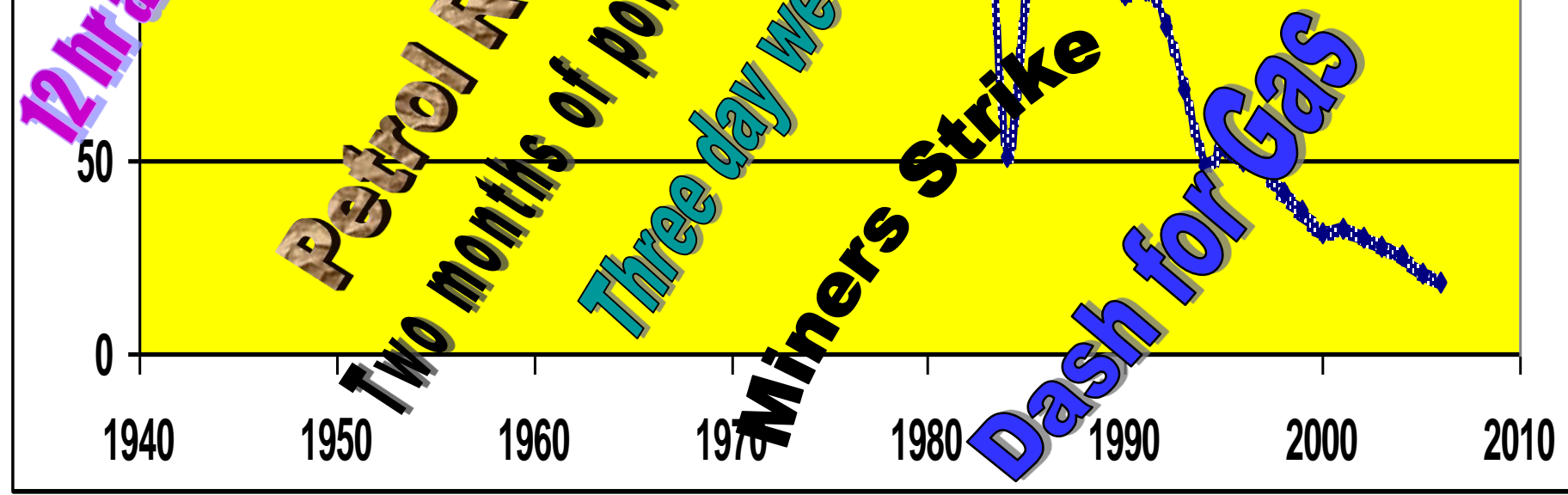
- **Are we really serious about CCS?**
- **How green is CCS?**
- **CCS and running the National Grid**
- **Is CCS R&D properly directed?**



Fred Starr's Energy Time Line



Coal Output
in
Tonnes



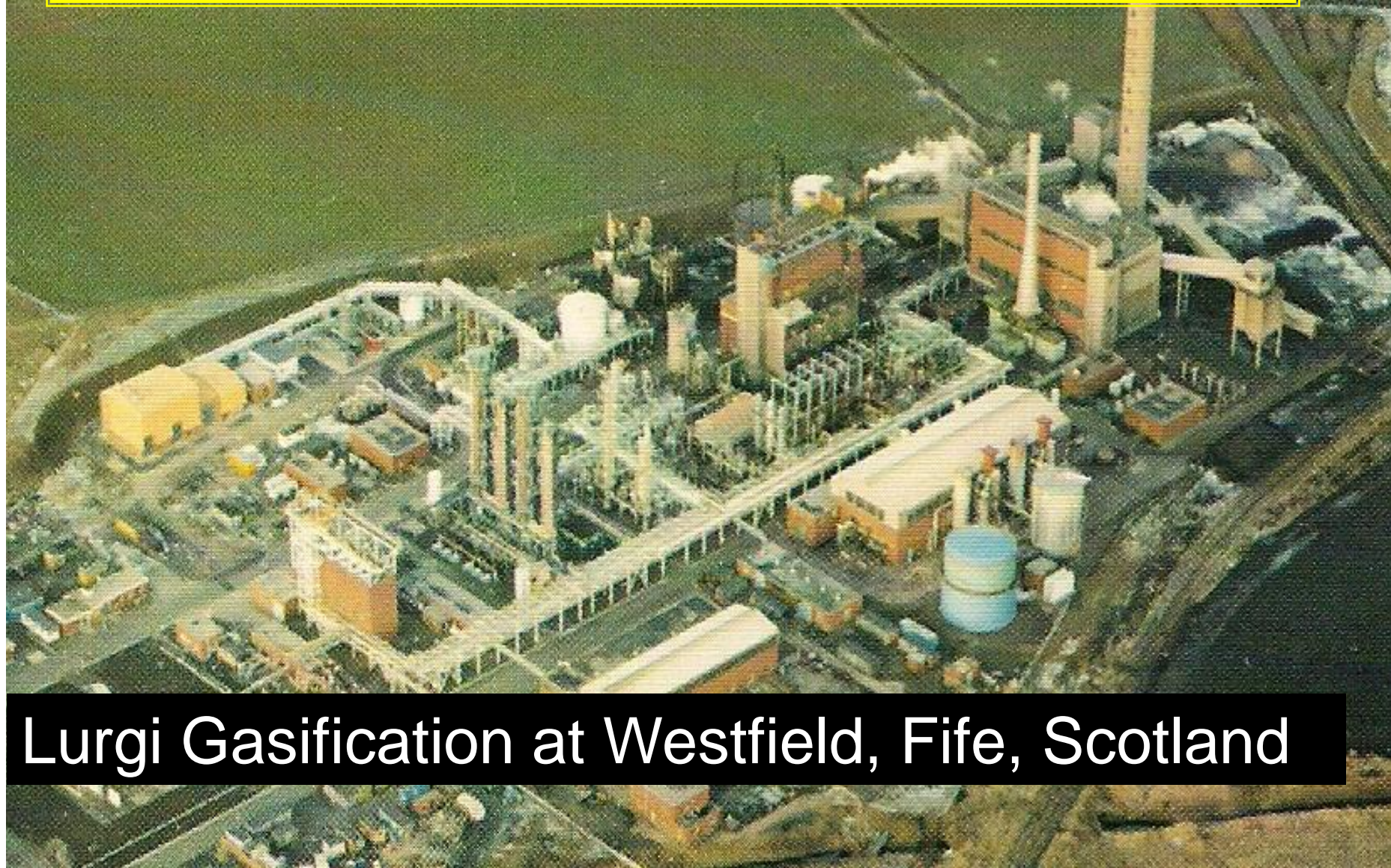
Global Warming and CCS- My View

Global warming seems to be happening
and
Man-made CO₂ may be a cause

**If Global Warming is happening its probably too late to
do much about it**

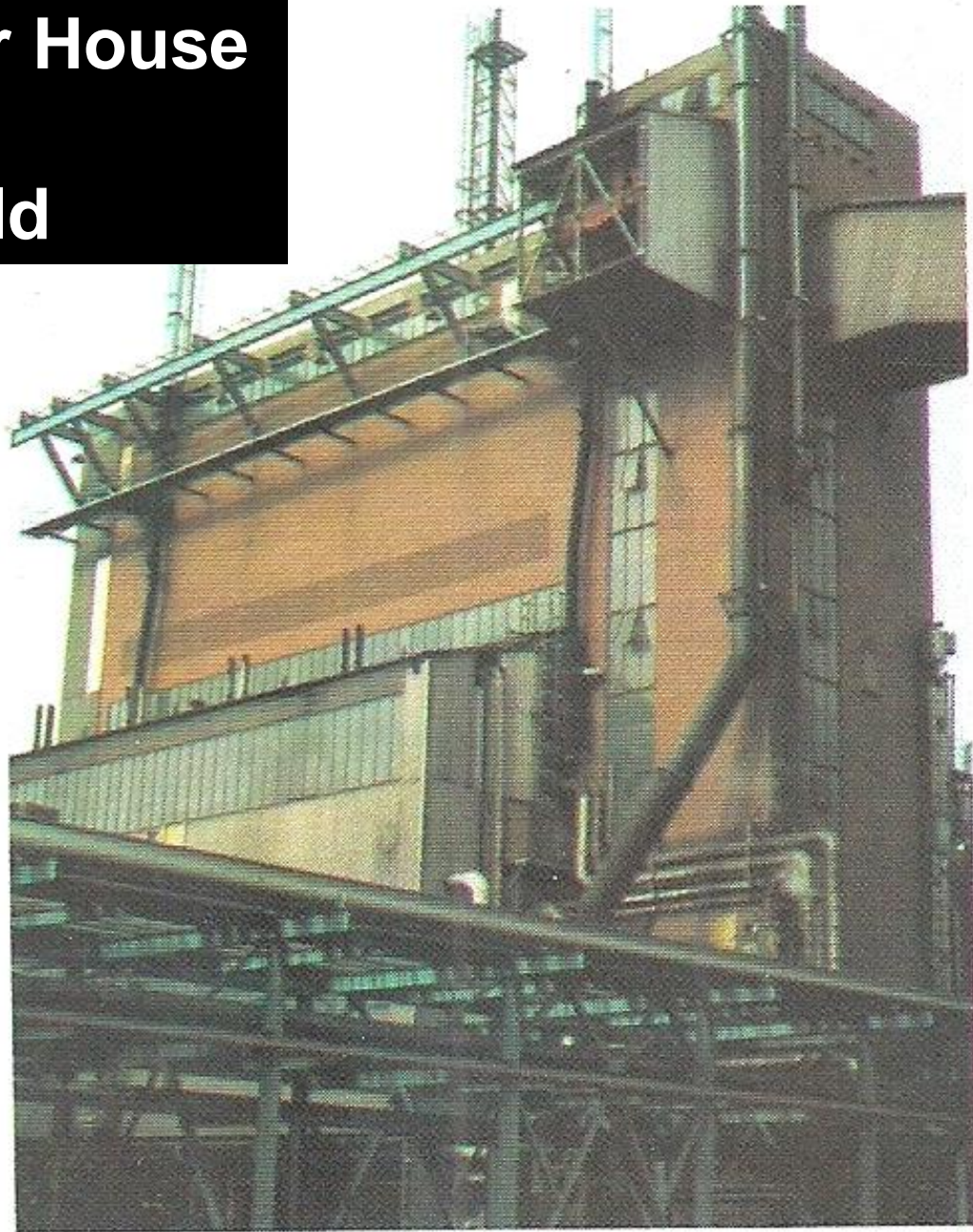
**If its not too late.....
We should be doing something about CO₂
NOW**

CO₂ Capture from Coal in 1961



Lurgi Gasification at Westfield, Fife, Scotland

Lurgi Gasifier House at Westfield



CO₂ Removal at Westfield by the Benfield Potassium Carbonate Process



CO₂ Capture from Oil in 1967

Benfield Plants



Oil Gasification at Granton, Edinburgh

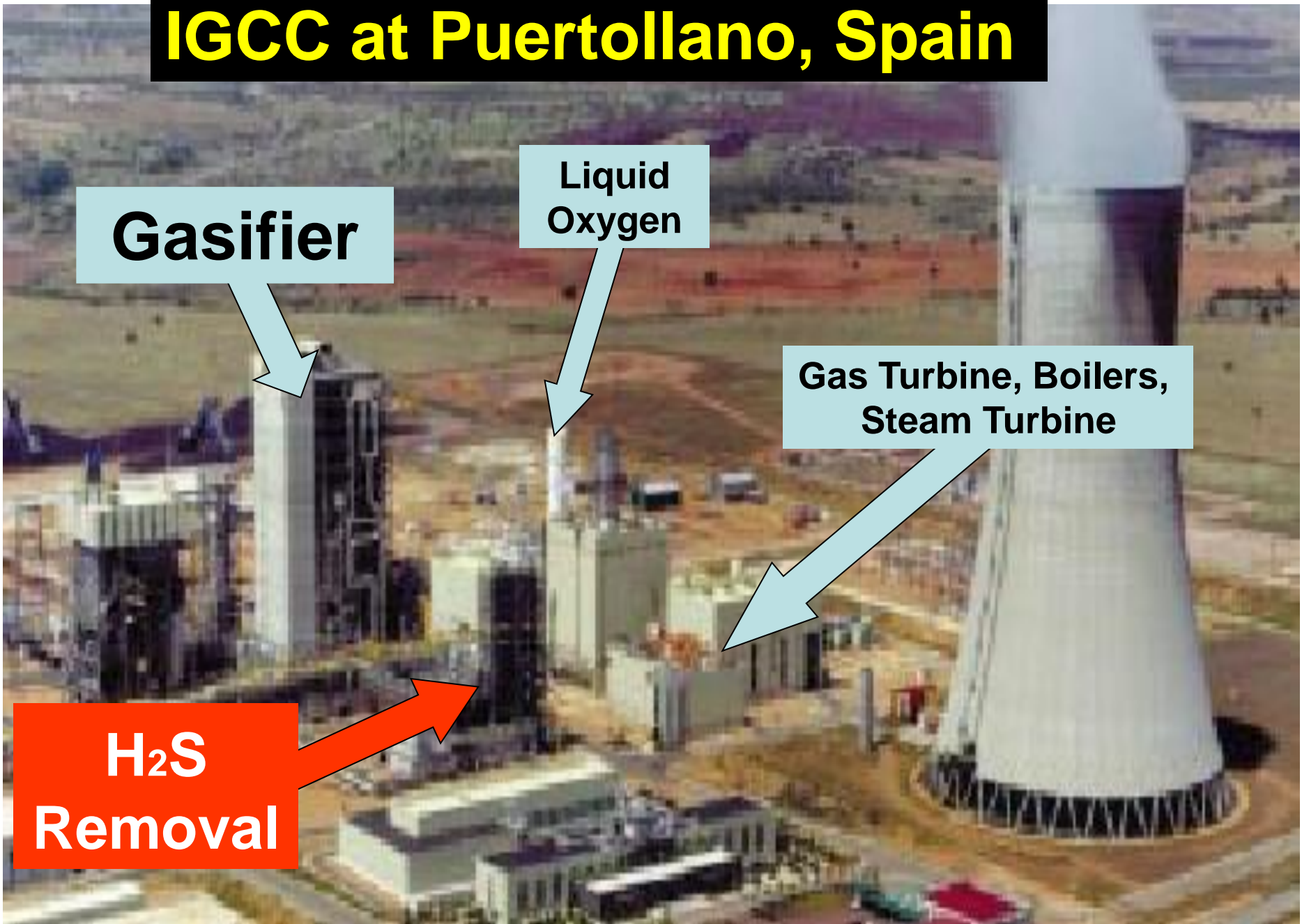
IGCC at Puertollano, Spain

Gasifier

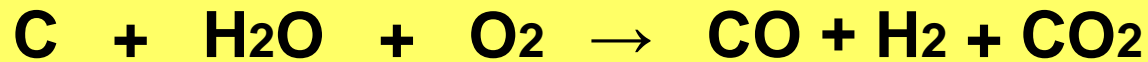
**Liquid
Oxygen**

**Gas Turbine, Boilers,
Steam Turbine**

**H₂S
Removal**

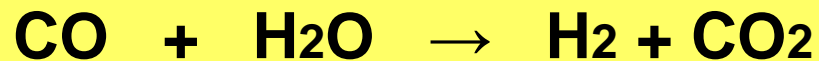


1. Gasification



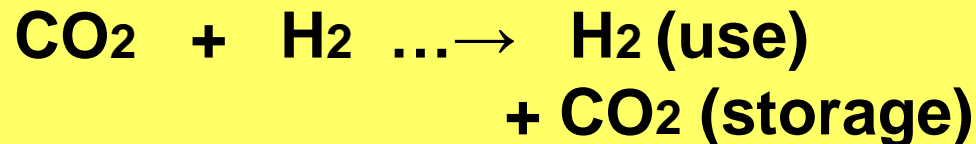
Coal + Steam + Oxygen \rightarrow Raw syngas

2. Shift Conversion



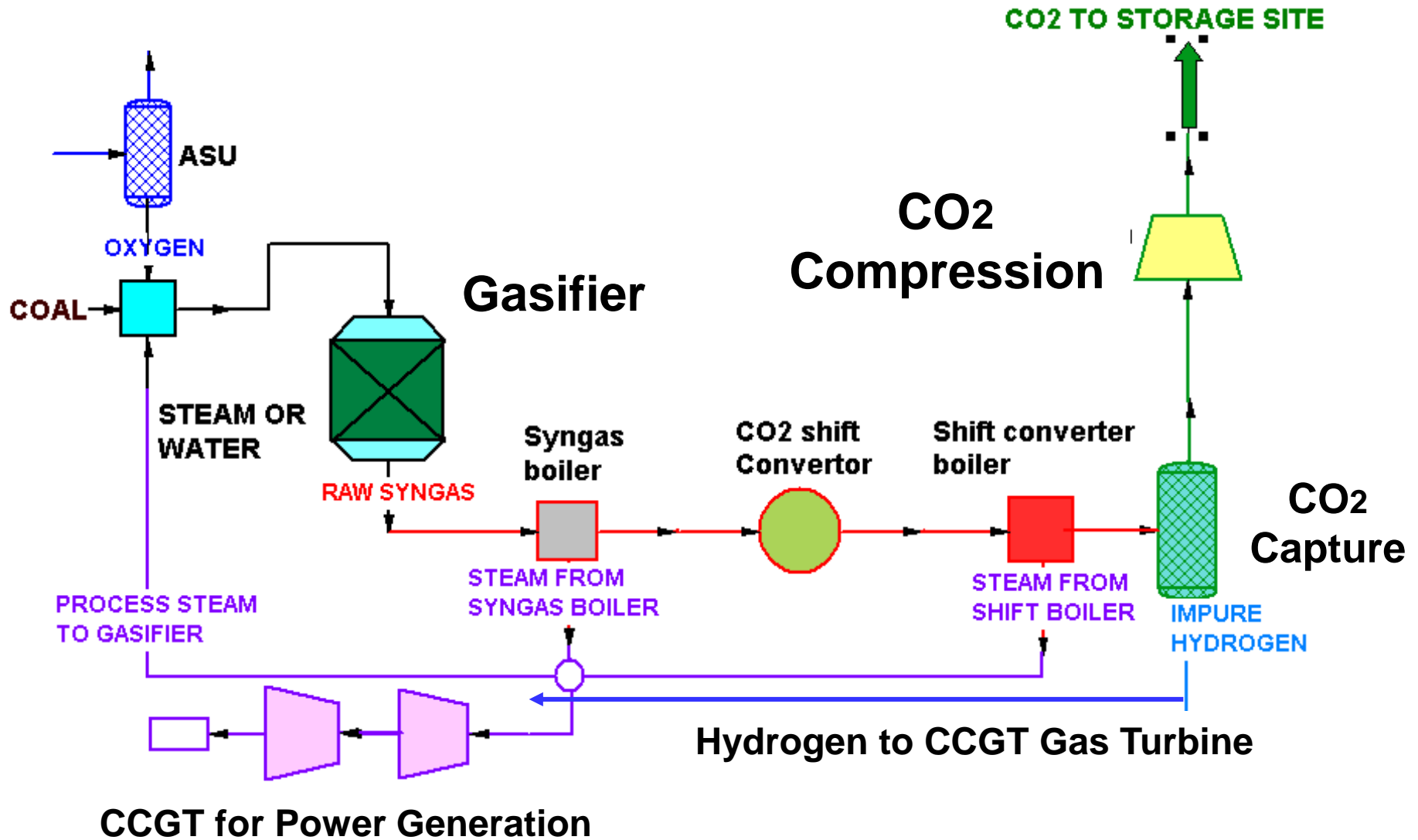
Syngas \rightarrow Shifted gas

3. Purification

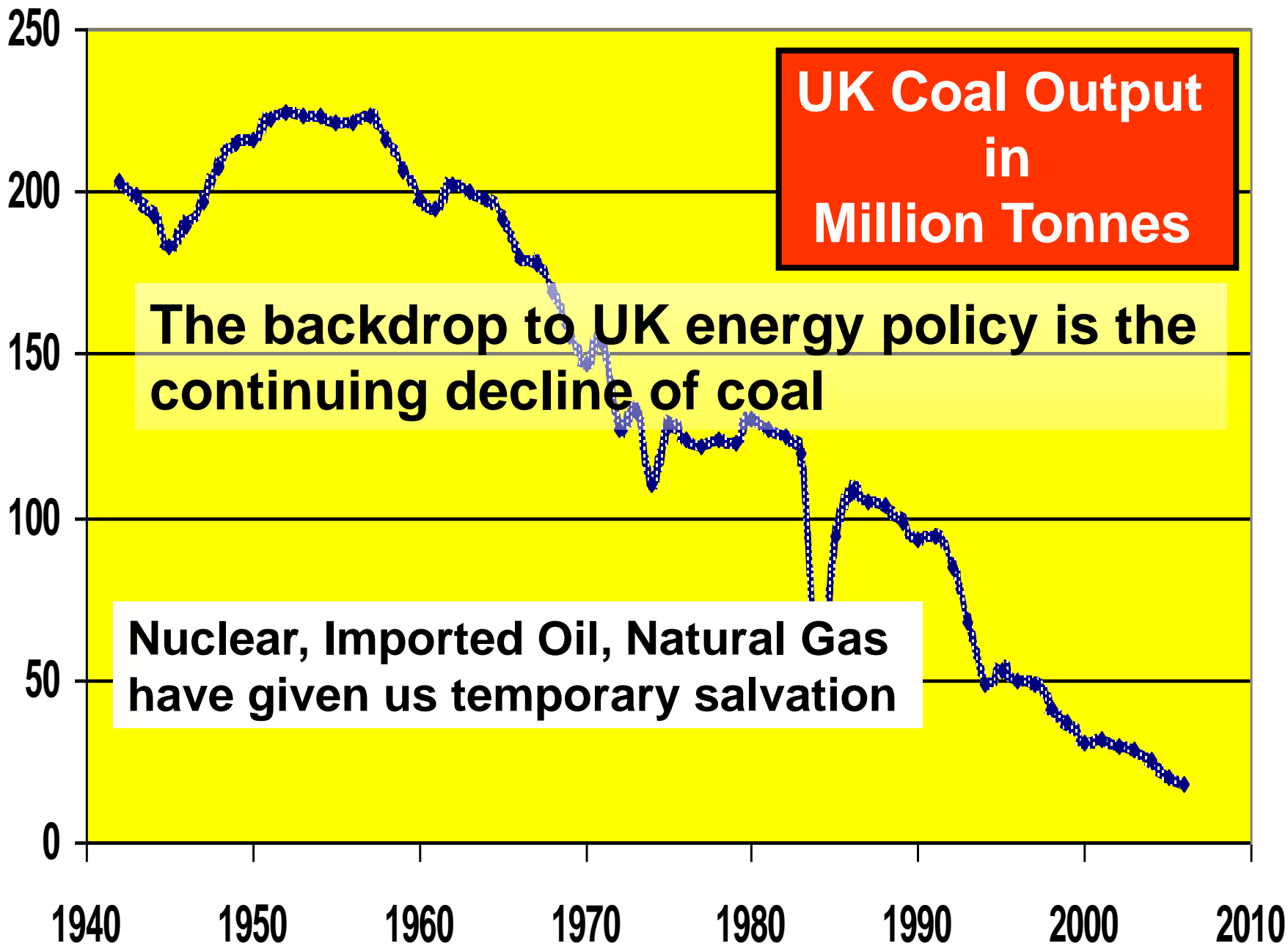


Unlike other processes, capability to remove all CO₂
Additional environmental benefits

Gasification Combined Cycle with CO2 Capture



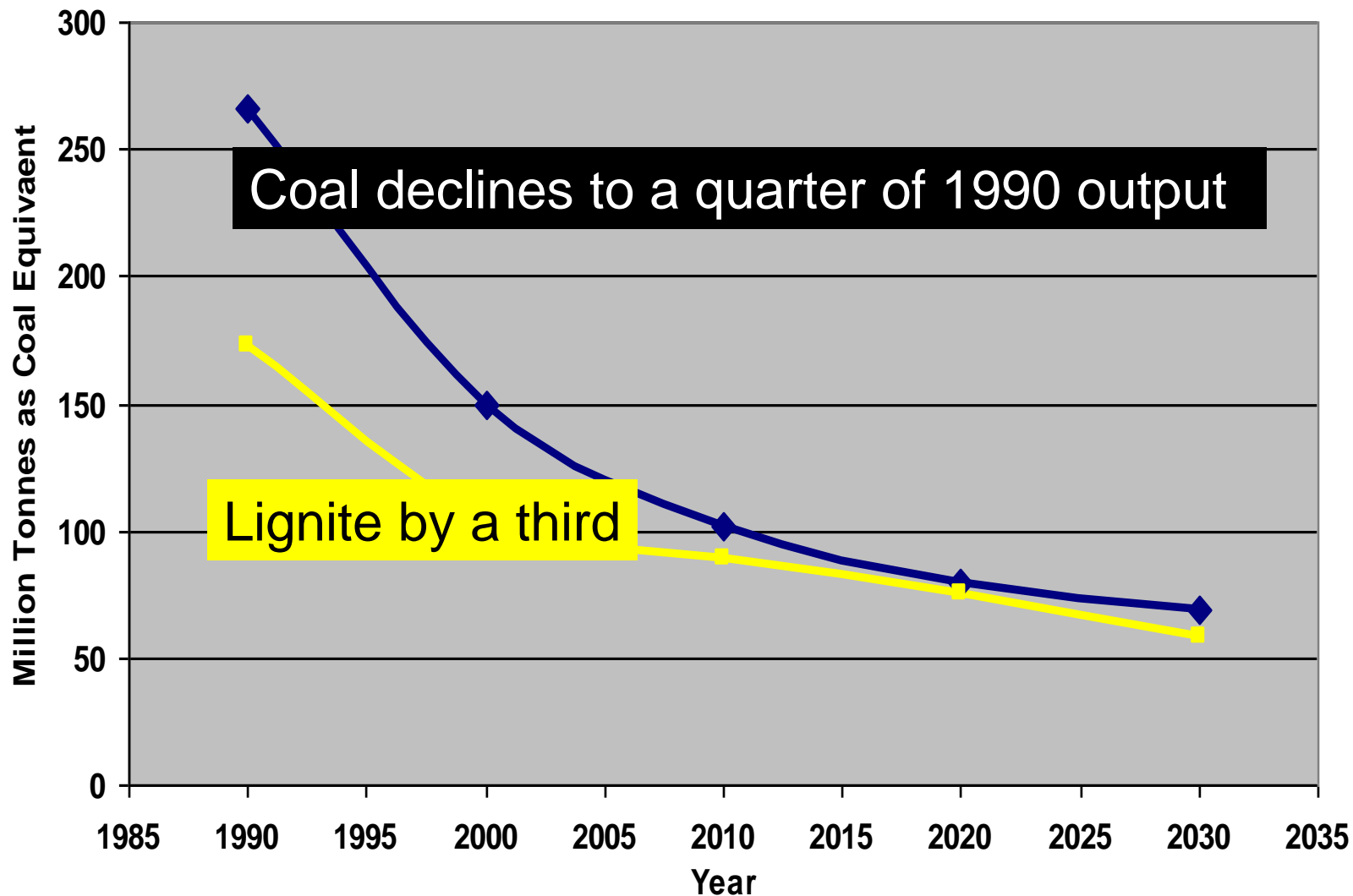
**If Gas is Running Out
is
CCS Coal the Answer?**



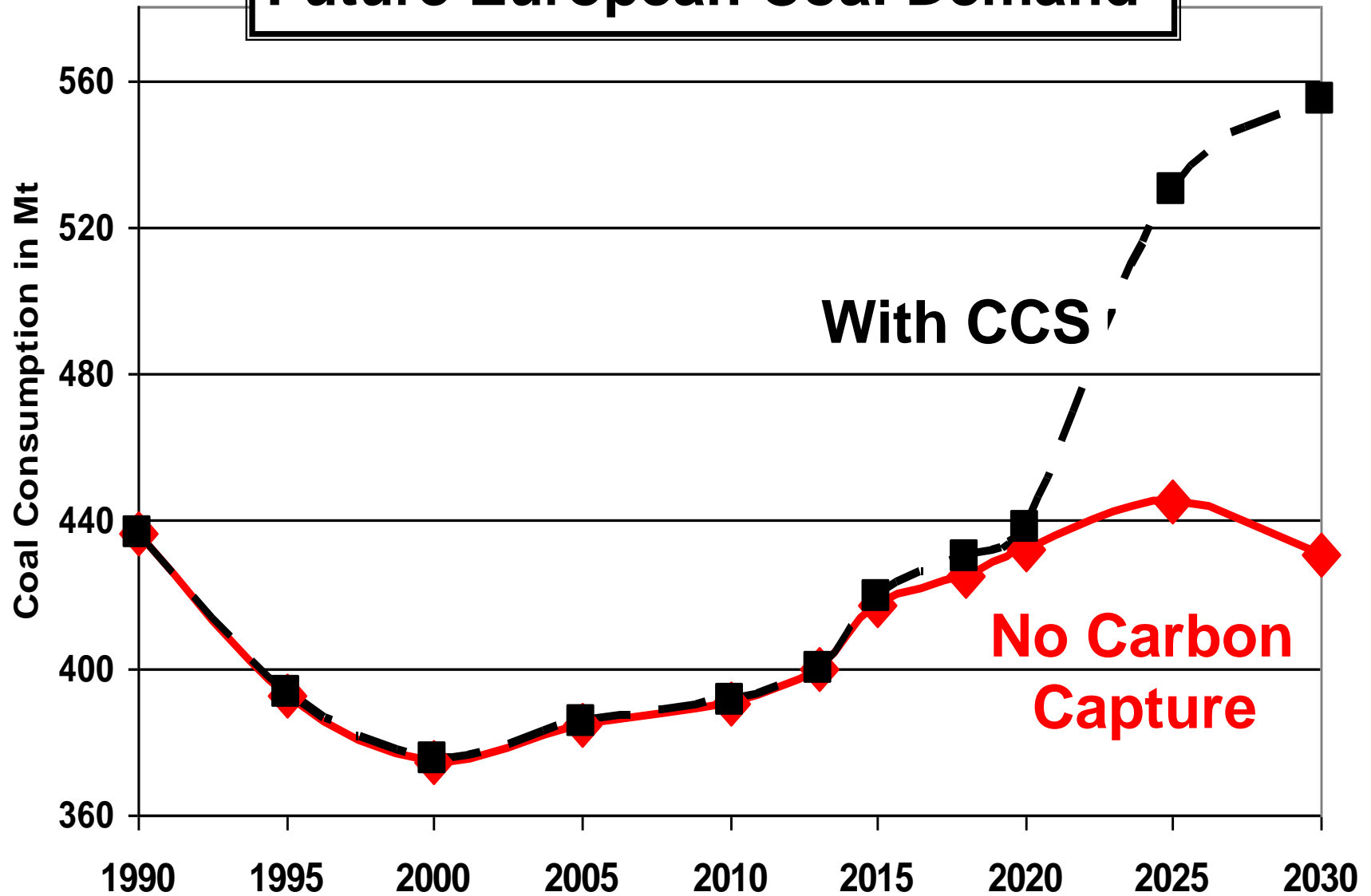
European Coal and Lignite Output Millions of Tonnes

	1958	2008
Belgium	30	Zero
Czechoslovakia	89	44
France	66	Zero
Germany	590	101
Hungary	28	2
Netherlands	13	Zero
Poland	113	114
Spain	19	10
UK	242	19
All Europe	c. 1200?	c.290

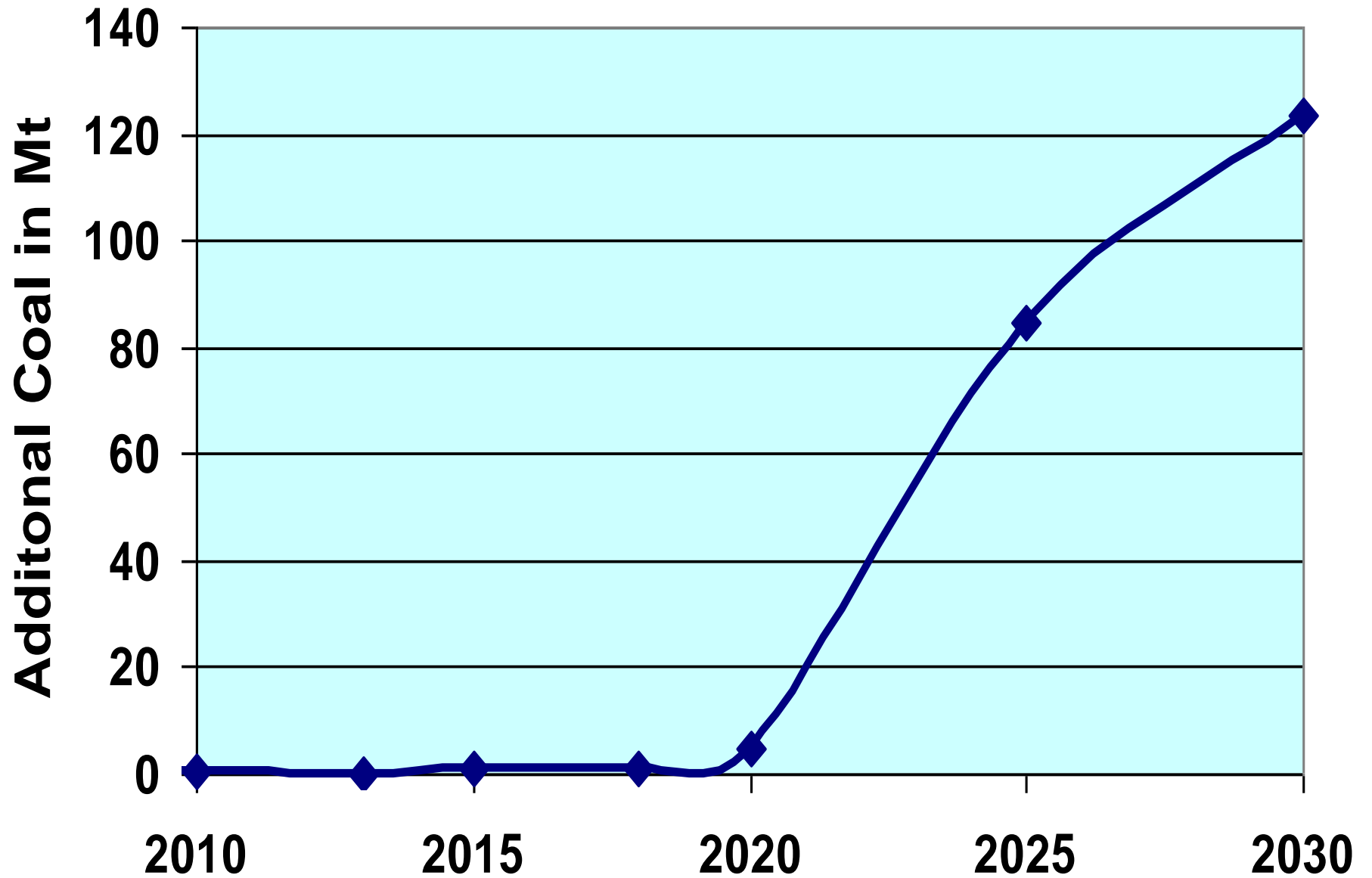
EU Coal and Lignite Production to 2030



Future European Coal Demand



Extra Coal Demand in Europe from CCS



Implications for the UK and Europe of CCS

European Coal Imports for power generation increase by 50%

Coal consumption increases rather than decreases

By 2030 all UK coal will need to be imported

**For 20 GW of CCS capacity coal consumption increases
from 44 to 57 million tonnes a year**

**UK will spend an extra half a billion to reduce CO₂ emissions
from coal fuelled electricity by 1%**

World Situation

If CCS is introduced worldwide this will increase demand by 1000 million tonnes per annum

This is equivalent to the USA coal output

Or

Half the output of China

Coal producers are very keen on CCS!!!

CCS Power Plants

and

Renewable Electricity

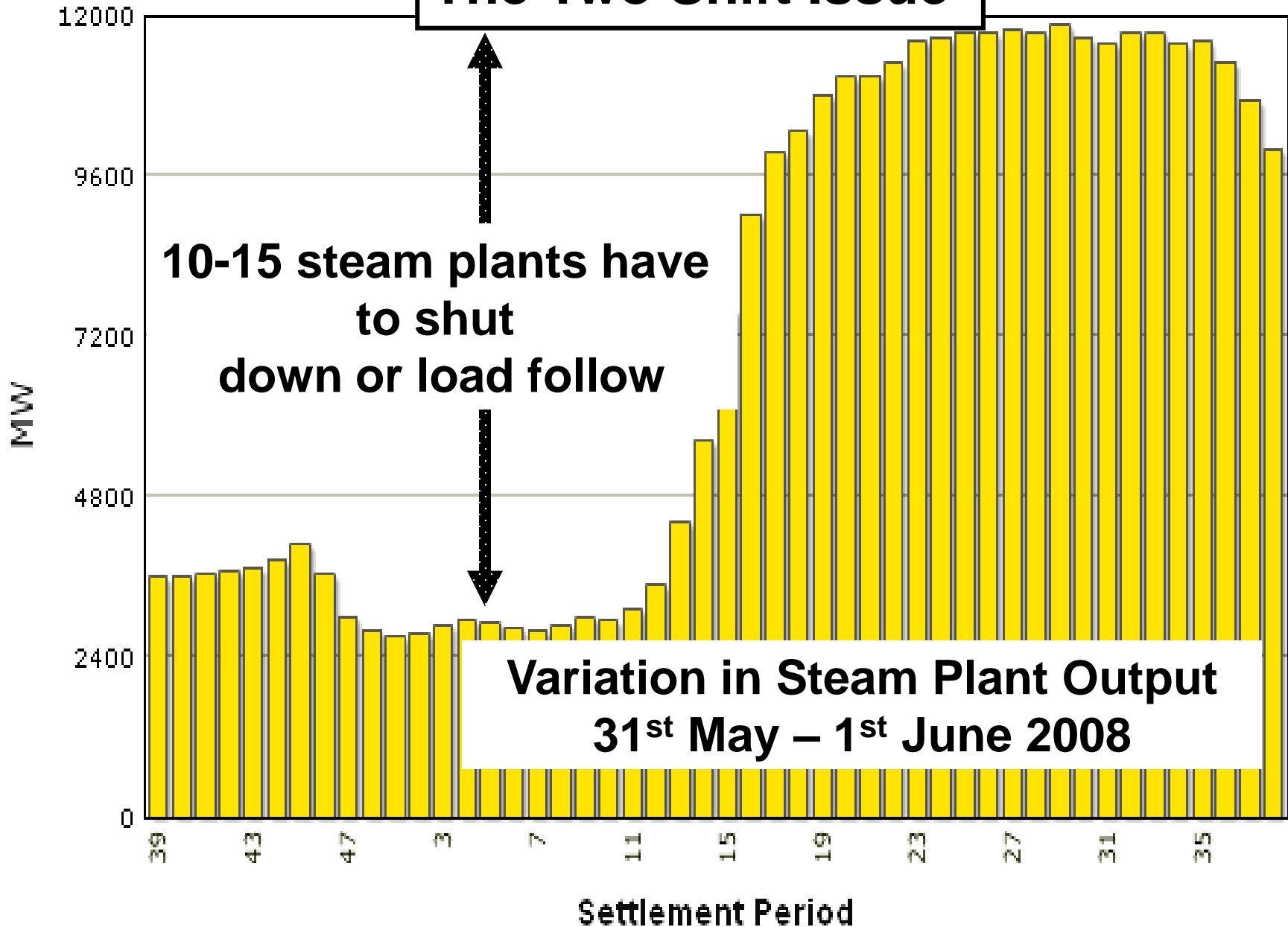
New UK Coal Fired Steam Plant is Needed

- Replaces obsolete 1960's generating capacity
- Gas becoming too expensive
- Required for **two shifting duties** to support base load nuclear
- Required as **back up** for wind and solar renewables

The Two Shift Issue

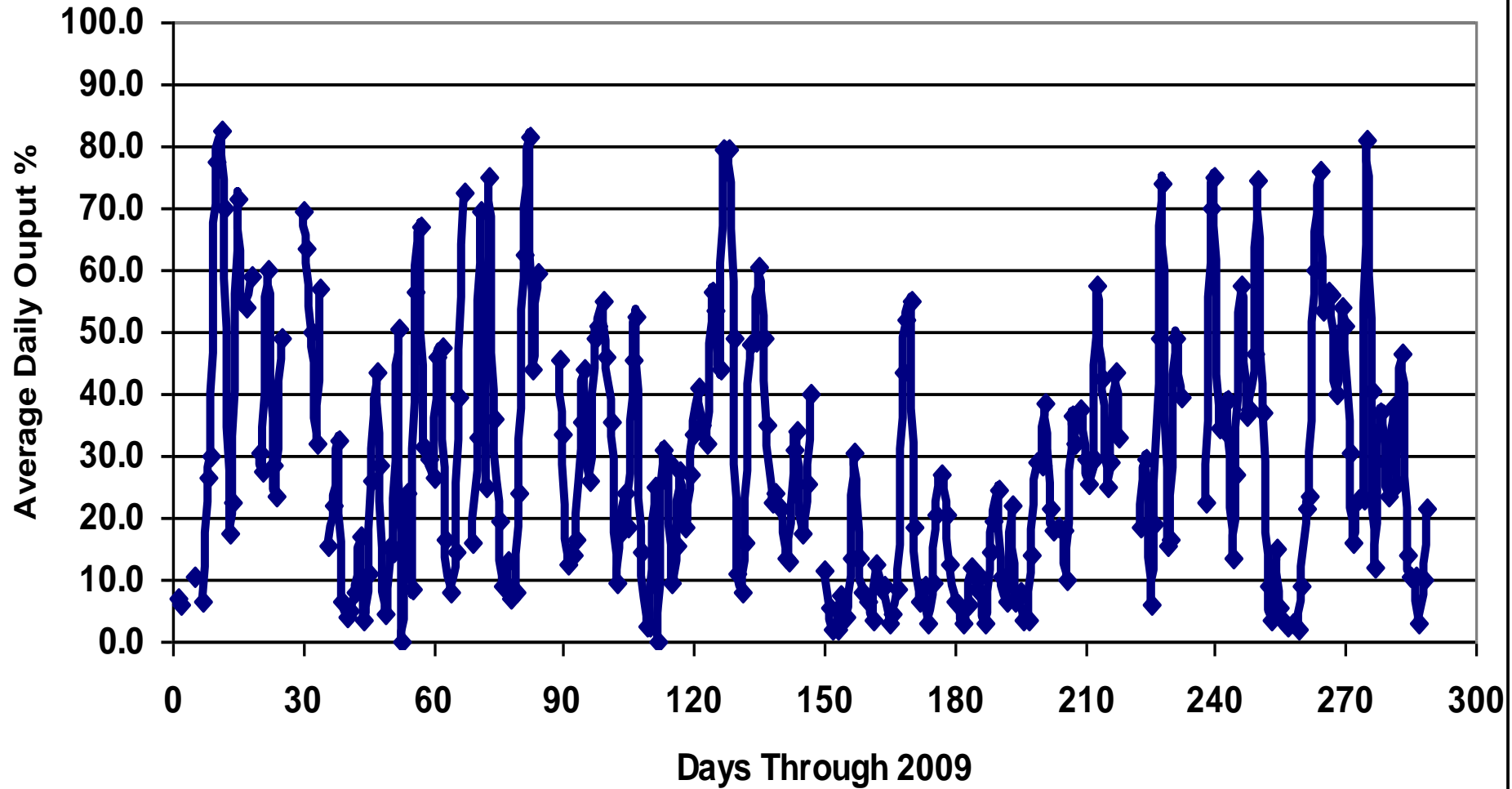
**10-15 steam plants have
to shut
down or load follow**

**Variation in Steam Plant Output
31st May – 1st June 2008**

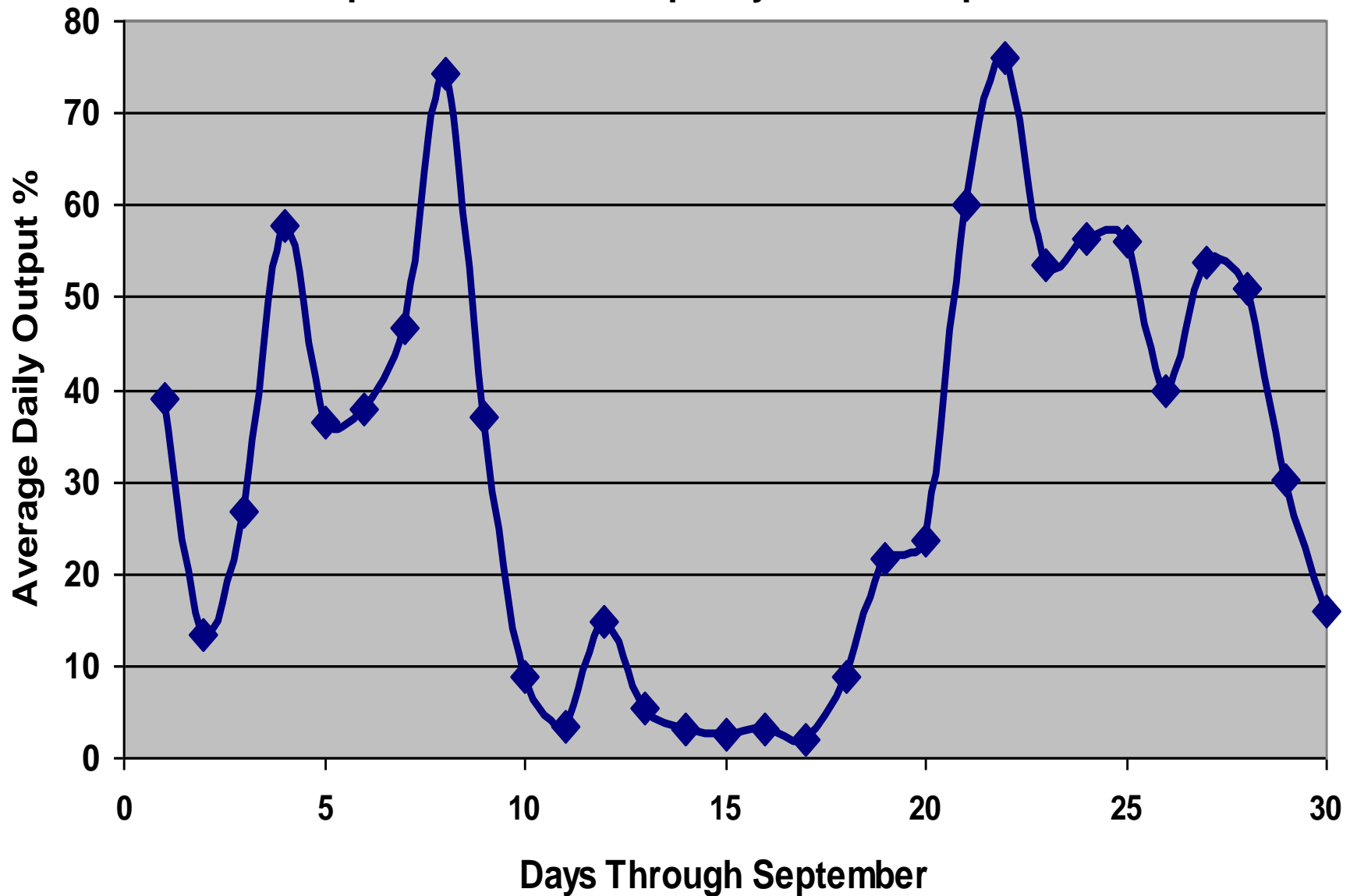


Proportion of Wind Capacity on National Grid

Jan-Sept 2009



Proportion of Wind Capacity on Grid Sept 2009



Coal Fuelled CCS Plants

- **High Capital Cost**
- **Maintenance issues resulting from on-off operation**
- **Higher CO₂ emissions during start up or operation at reduced loads**

Fairly useless for Two Shifting and Back Up for Wind

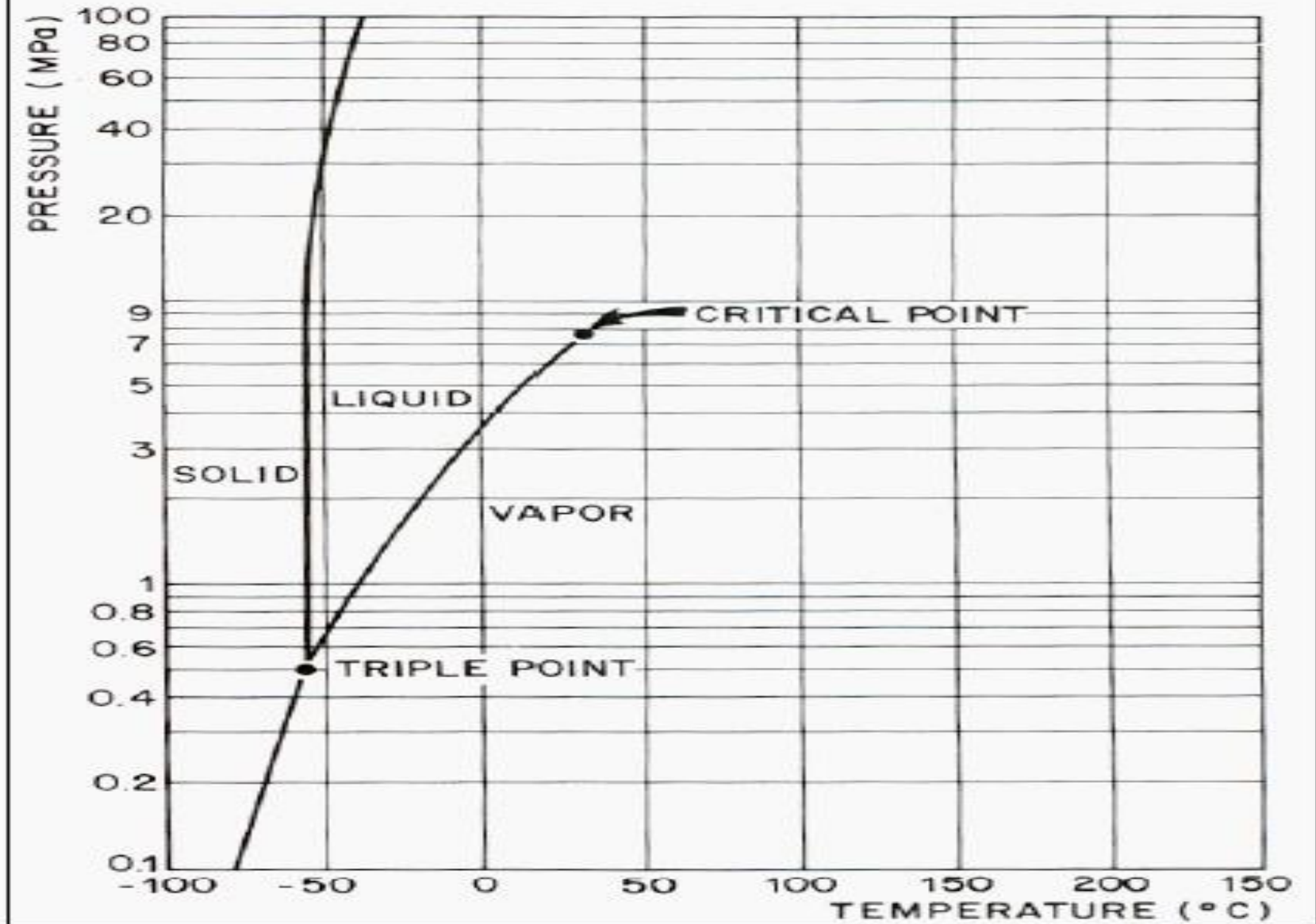
 **Less than 4GW of CCS by 2030**

Geological Storage in the North Sea

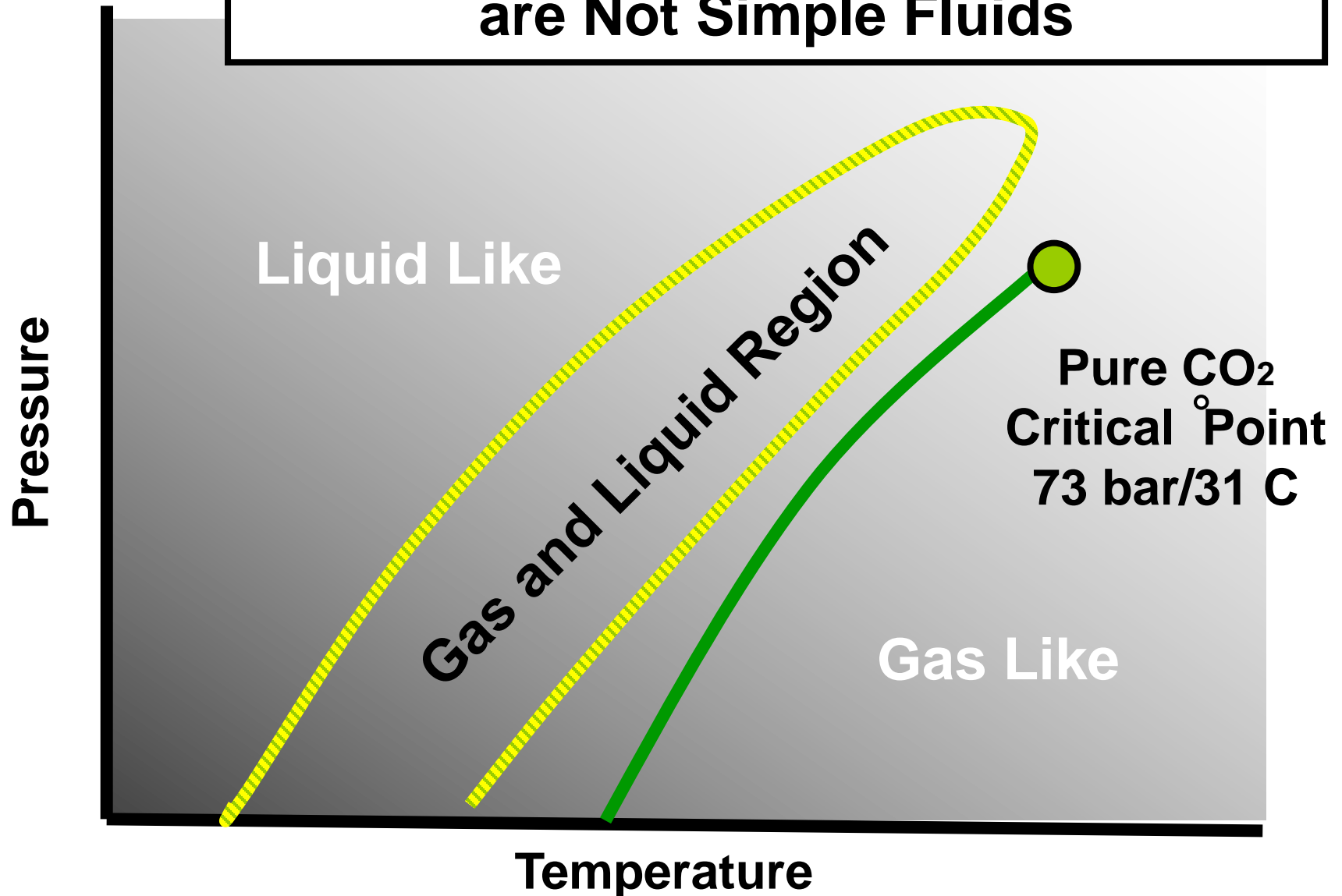
Transmission to and Storage in the Geological Site

- **The Critical Pressure Issue**
- **Rig Blow Outs**
- **Simple Storage**
- **Enhanced Oil Recovery**

Phase Diagram for Pure CO₂

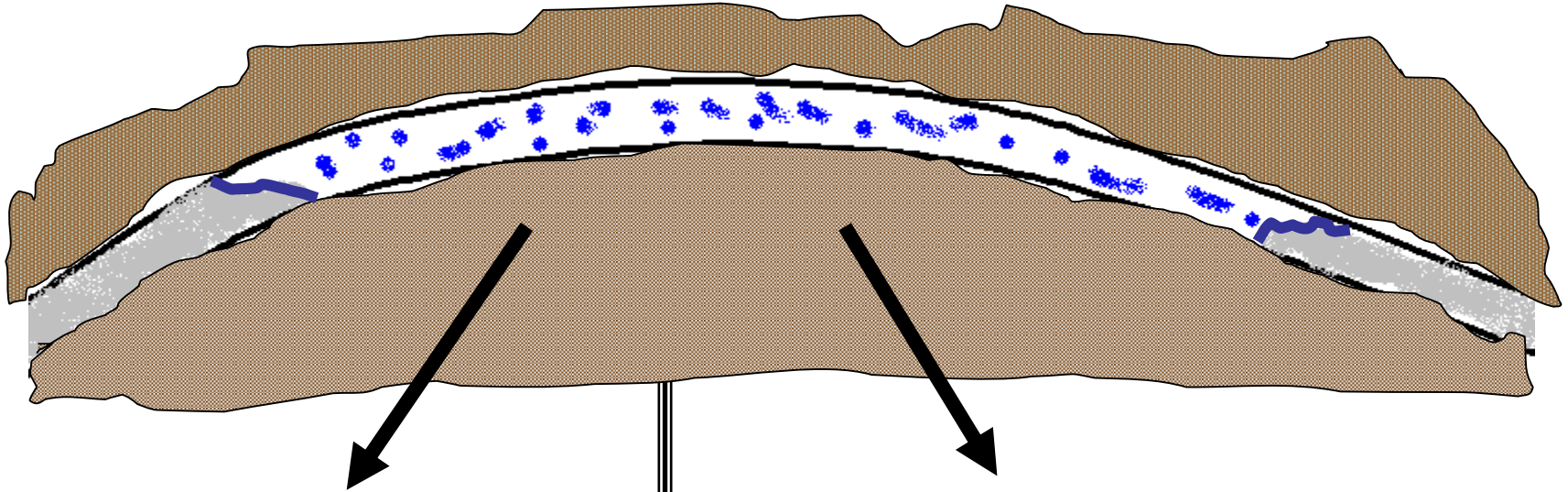


Real Mixtures of CO₂ and Other Gases are Not Simple Fluids



Moving CO₂ by Pipeline

Need to avoid two phase (gas-liquid) flows



**Gas pipelines
would need derating
from 70 to 40 bar**

**New offshore pipelines
need to be designed for
110 bar pressure**

Dealing With a Blow Out on a CO2 Storage Rig?

Its a gas, at 200 to 400 bar pressure, not an escape of liquid

No fire ????

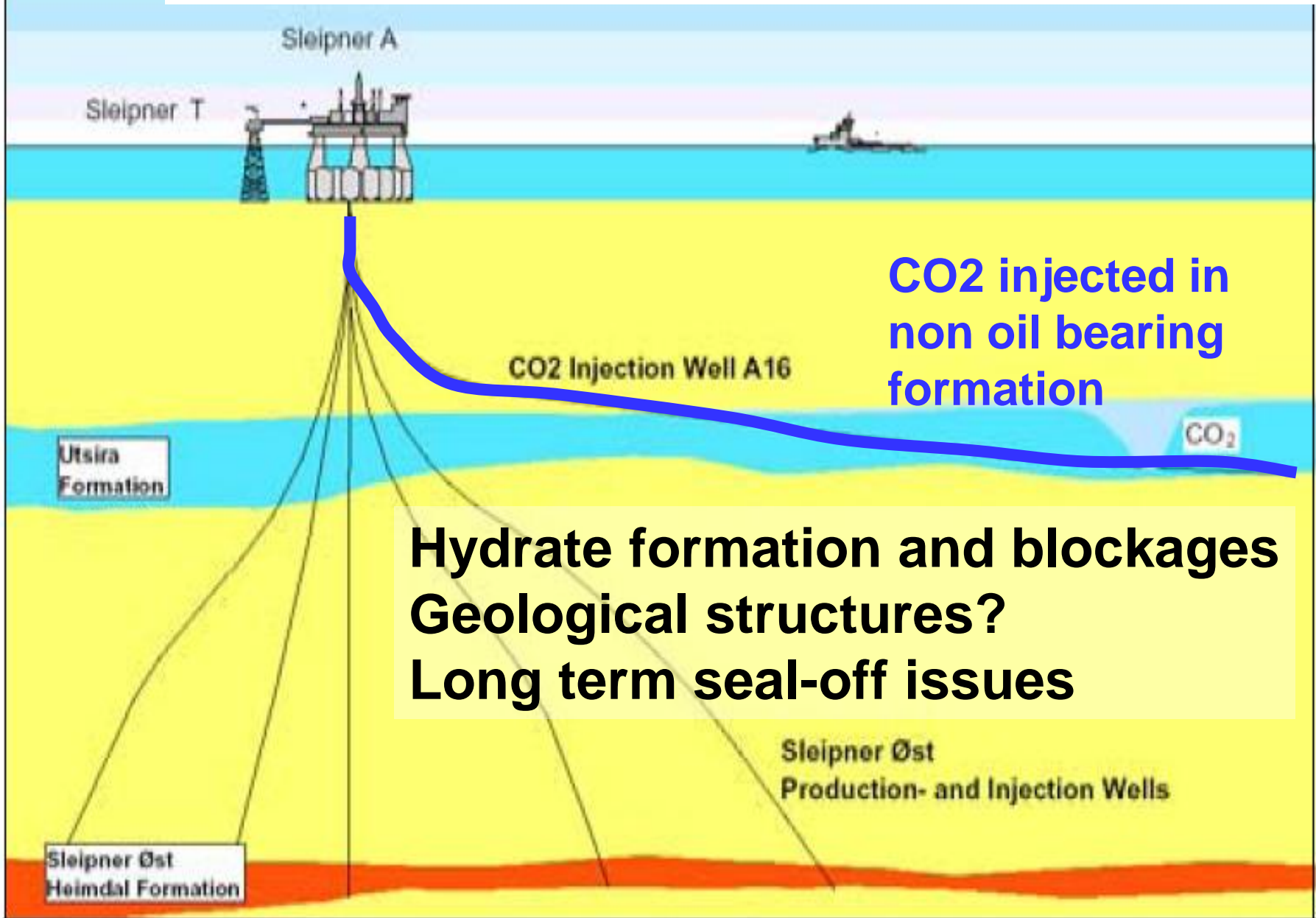
CO2 exits at supersonic velocity

Cooling and embrittlement of pipe

Dense CO2 cloud hampers repair attempts



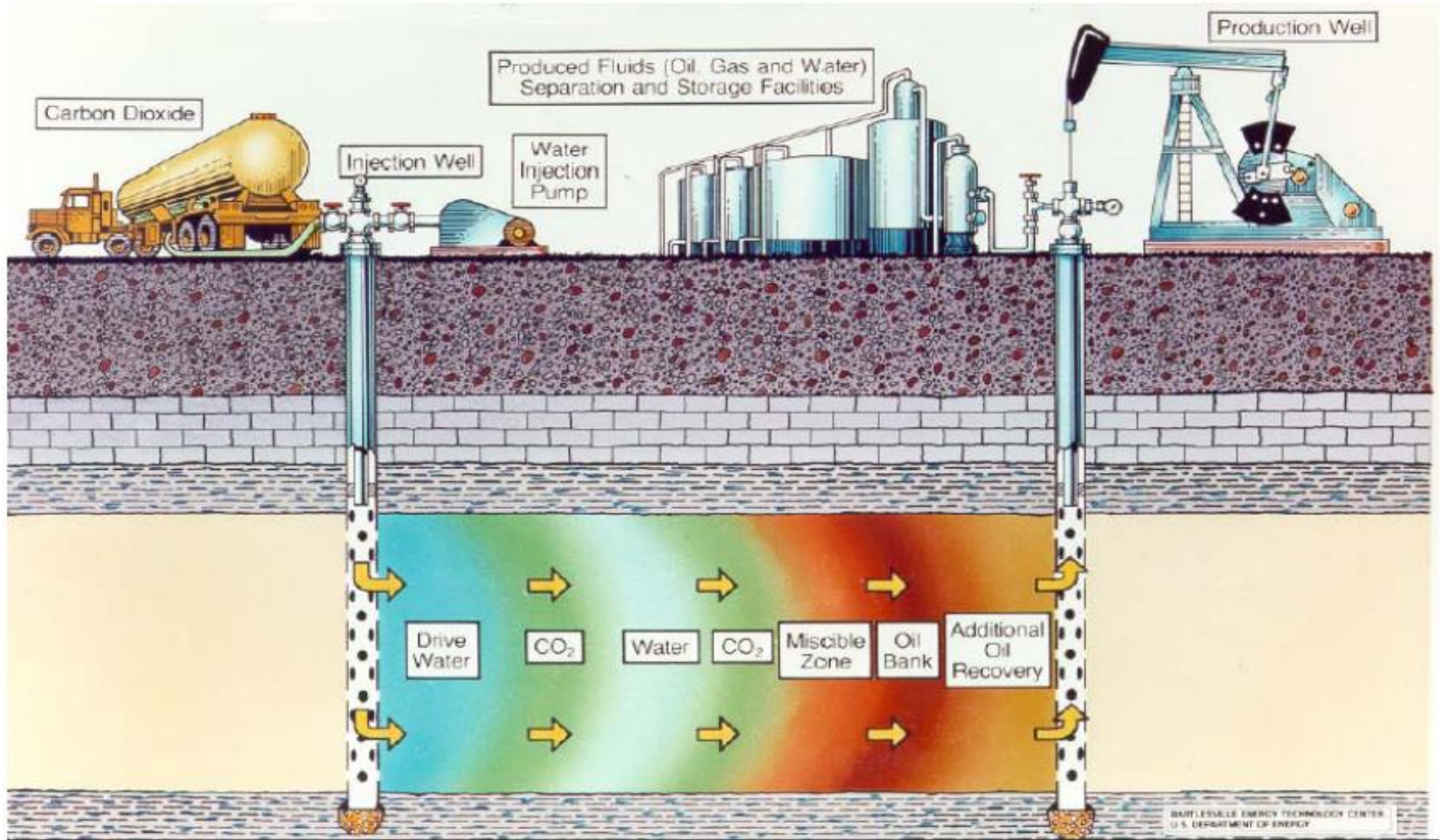
Simple CO2 Storage Seems Straightforward



Enhanced Oil Recovery

(Storage which pays for itself?)

CO₂ mixes with trapped oil, reducing its viscosity, increasing its volume and driving it to the well head



But EOR.....

Is not a fill a forget process – CO2 injection has to be **alternated with water**

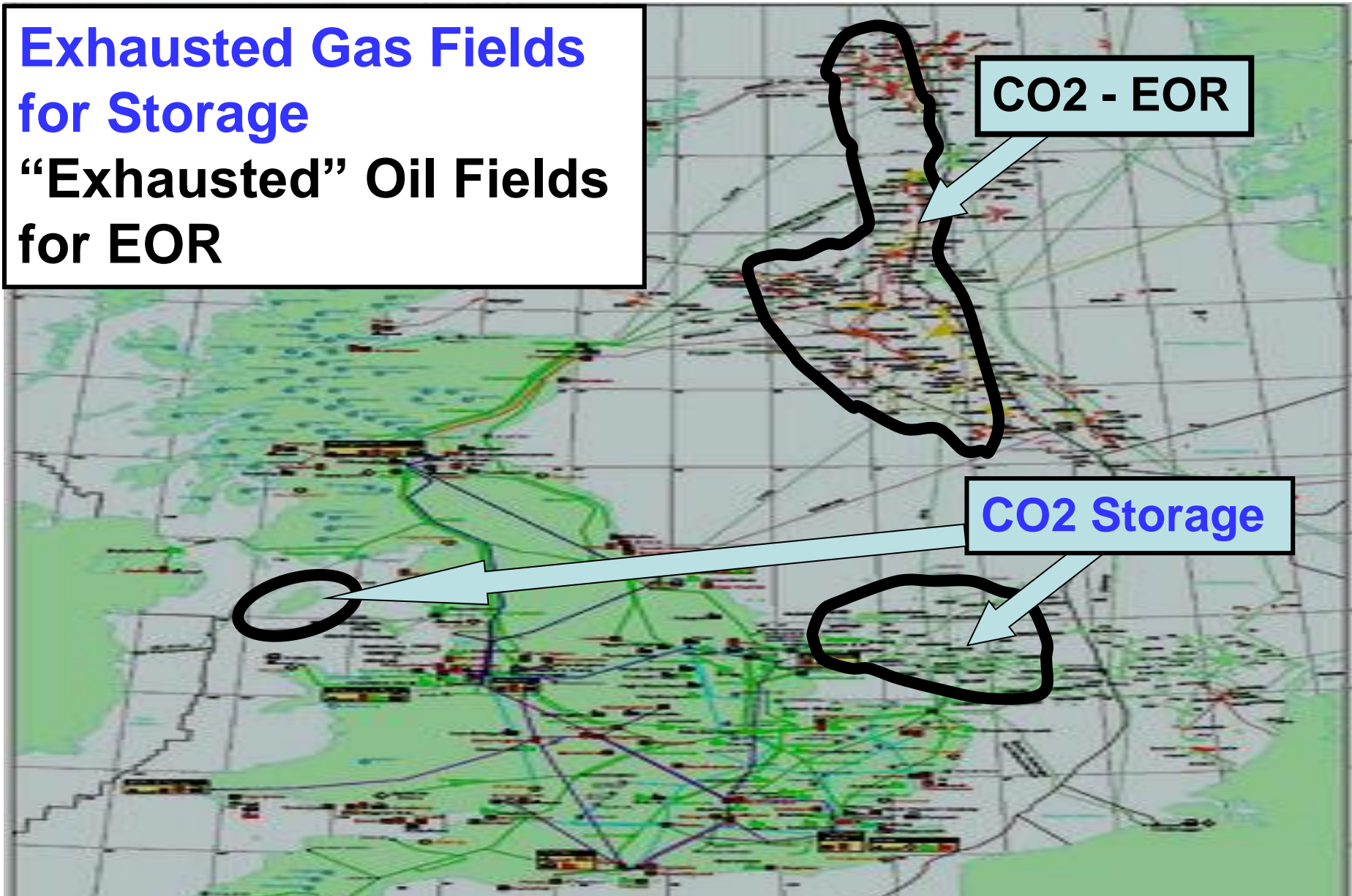
CO2 in recovered oil has to be **reinjected – less scope for storage**

CO2 acidified water is very **corrosive – corrosion resistant alloys and coatings needed**

North Sea geology of **oil reservoirs is complex- risk of oil being left behind**

Exhausted Gas Fields for Storage

“Exhausted” Oil Fields
for EOR



EOR reservoirs are a long way from good power plant sites

In Conclusion

**Priority should be reducing energy imports
and energy conservation**

The big issue is renewable heat to replace gas

**CO₂ Capture plants of the IGCC type
could be operating now**

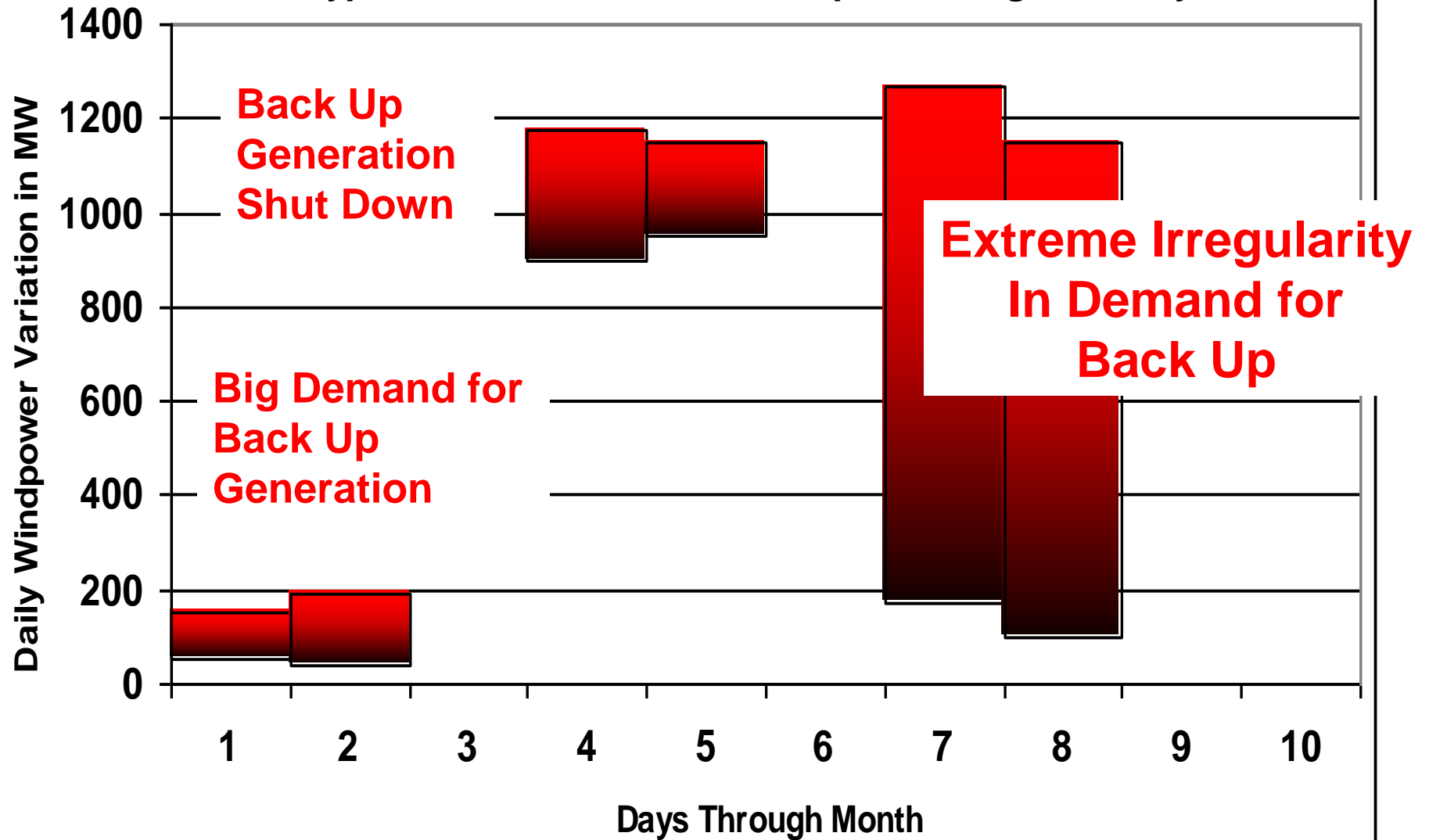
**Too much focus on capture-
not enough on storage**

**World wide CCS will create another energy crisis
because of the need for extra coal and gas**

Thank You

Fred Starr

Typical Variation in Wind Output During One Day



Daily Variation in Power Output in September 2009

