

Integrating CO₂ into the value chain – the Role of Chemistry



EuCheMS



European Chemical Sciences



European Economic and Social Committee

a bridge between Europe and organised civil society

The twin problems of fossil fuels

Reserves (Current usage)

Oil 50 years

Gas 55 years

Coal 100 years

Fracked gas and shale oil?

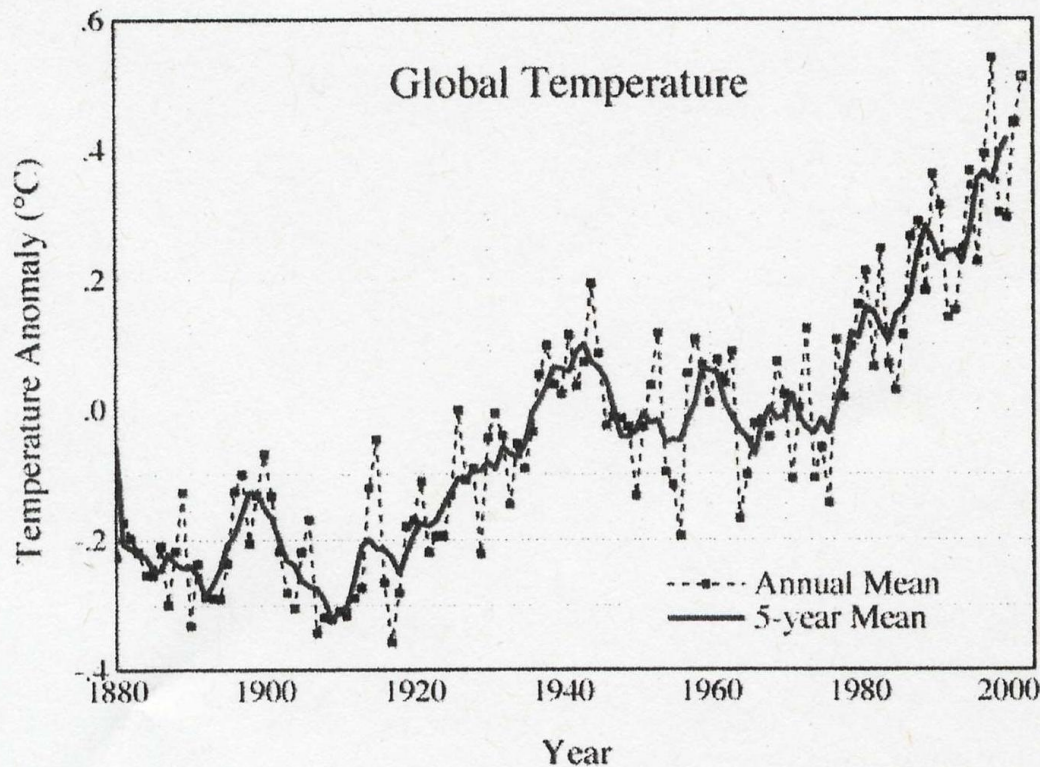
Energy return on energy investment EROEI is low (12 – world economy could be destabilised at 10)

	Oil	Gas	Coal	Population
China	12.1	4.8	50.3	19.24
India	4.2	1.5	8.5	17.5
USA	19.9	22.2	11.9	4.45

Global Warming and Climate Change

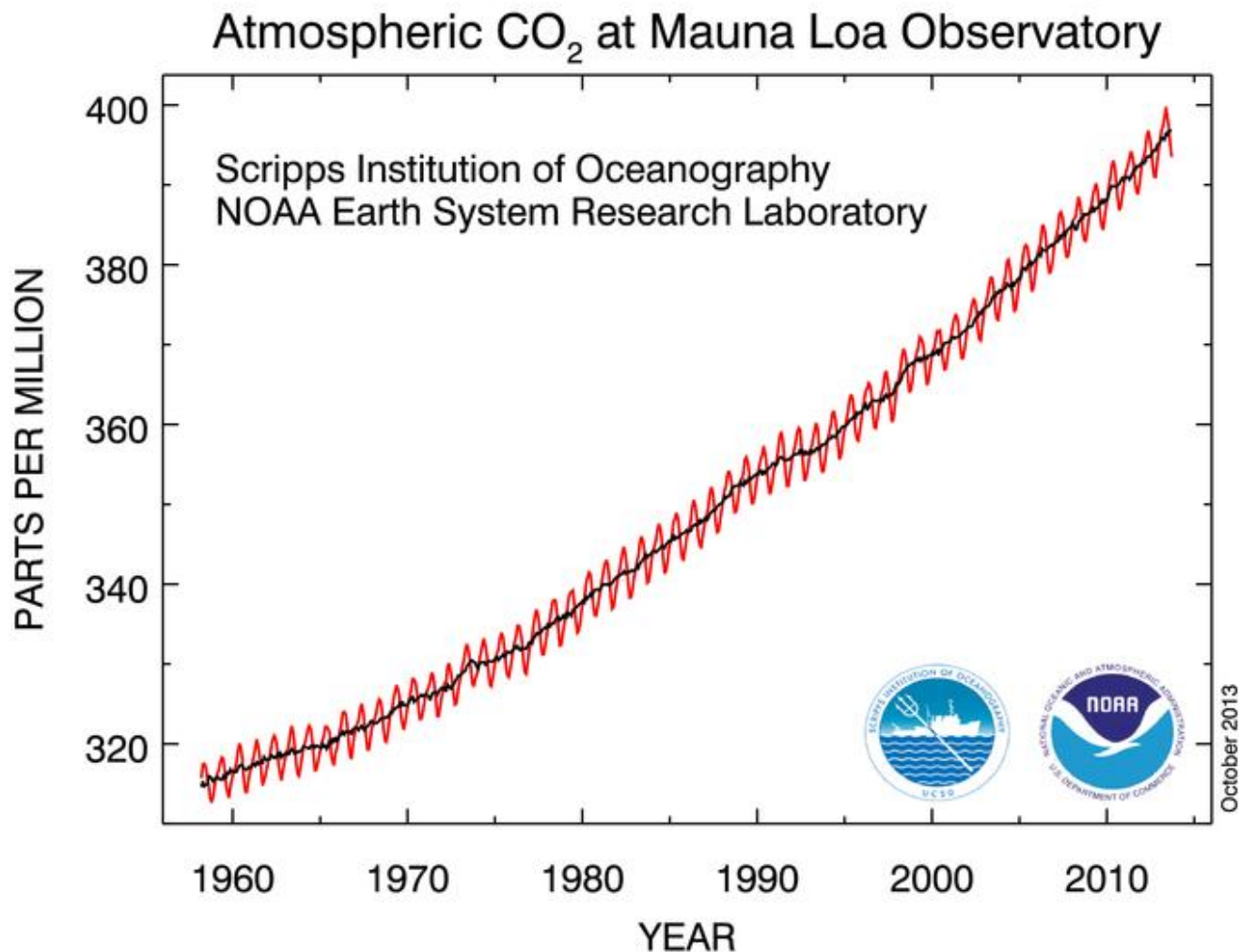
BP Statistical Review of World Energy 2014

Is Global Warming Real?



Mean global temperature relative to average for 1951-1980. Goddard institute for Space Studies. <http://www.giss.nasa.gov/research/observe/surftemp/>

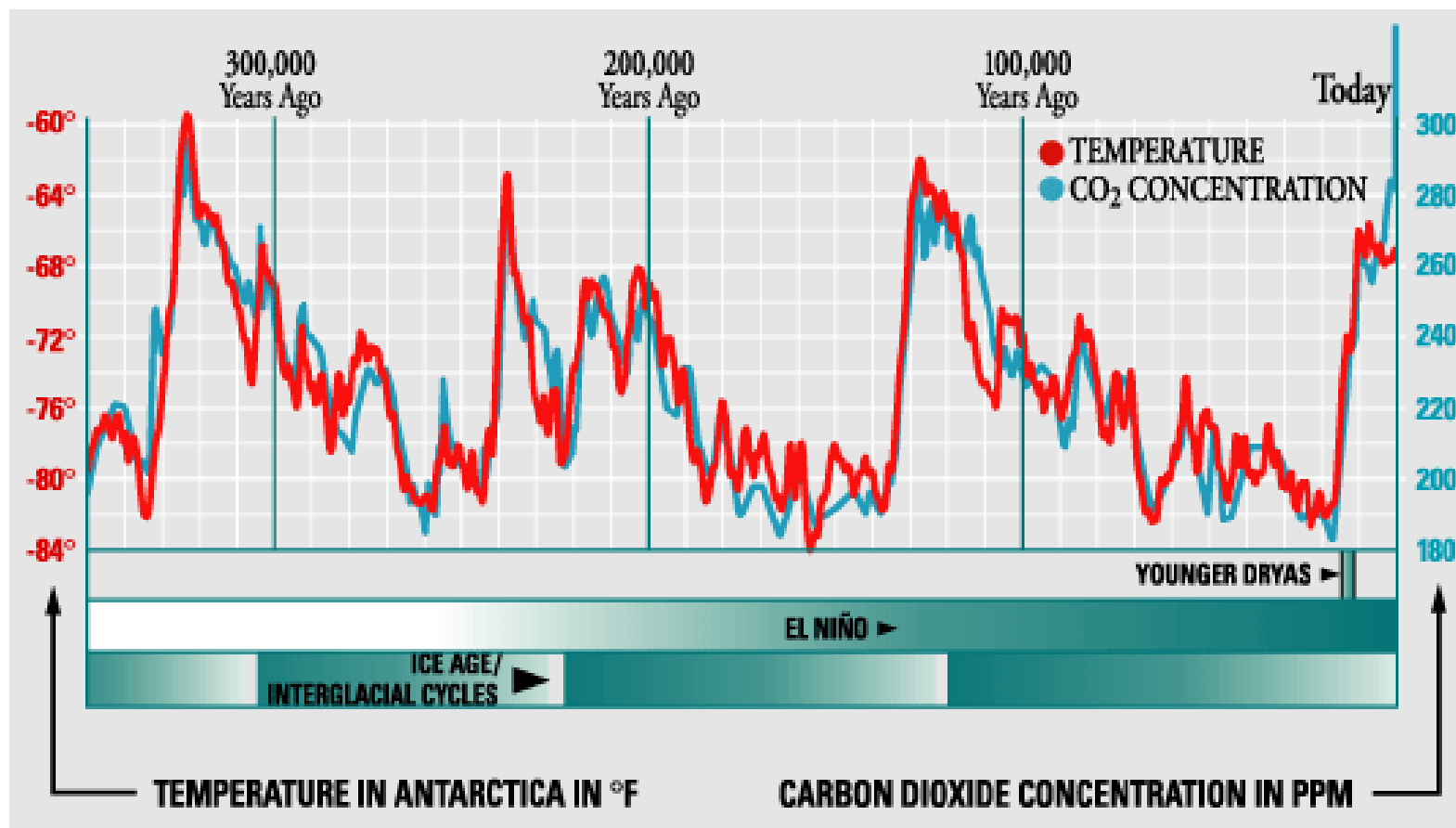
Are CO₂ levels rising?



> 20 % in 40 years mainly from burning fossil fuels

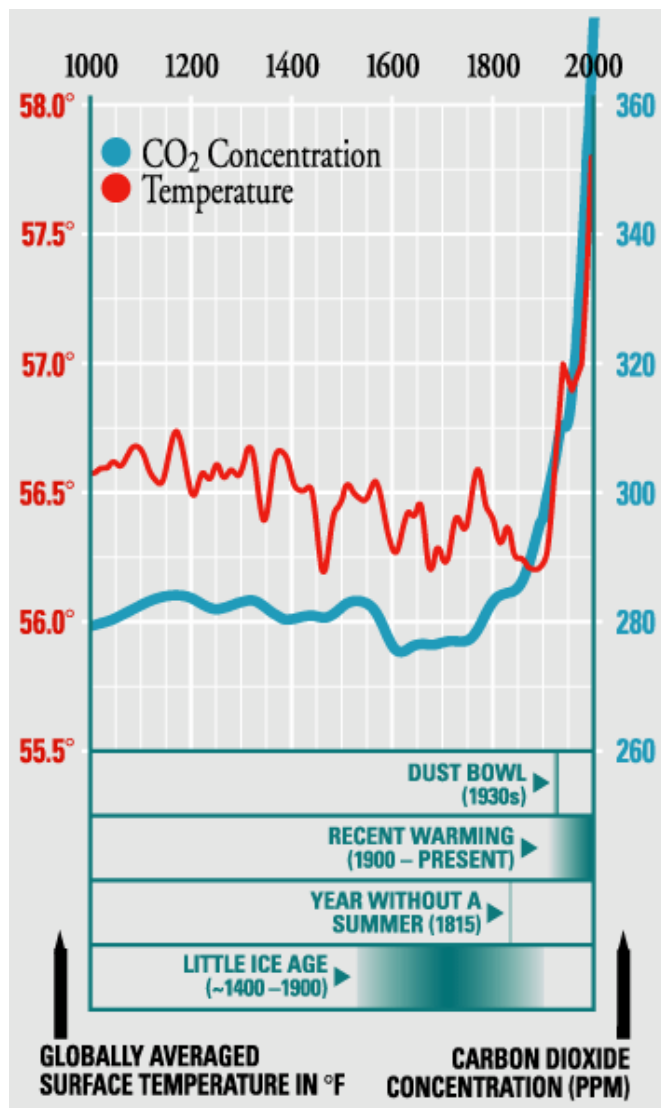
Are CO₂ levels and temperature related?

Analysis of ice cores in Greenland



CO₂ rises *follow* rises in temperature, so do not cause the rises in temperature

Recent rises in CO₂ and temperature

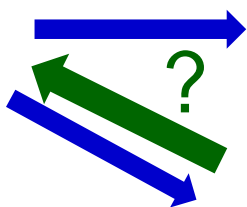


Temperature rise occurred *after* rise in CO₂ levels

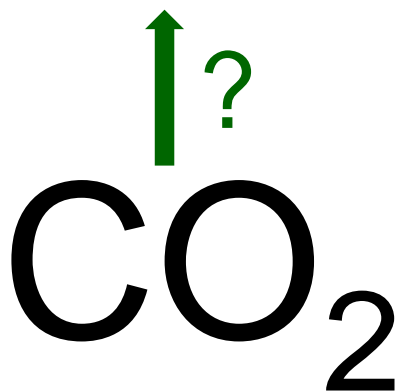
Almost all scientists now believe that increased global warming is caused by the actions of mankind

Can the problem also be the solution?

We need a new carbon source
We need to remove CO₂ from the atmosphere



Chemicals (<10 %)



Fuel →

hydrogen

gasoline



Gasoline from CO₂ Problems

Distribution of CO₂

- 400 ppm in atmosphere

BUT



12-14 % CO₂

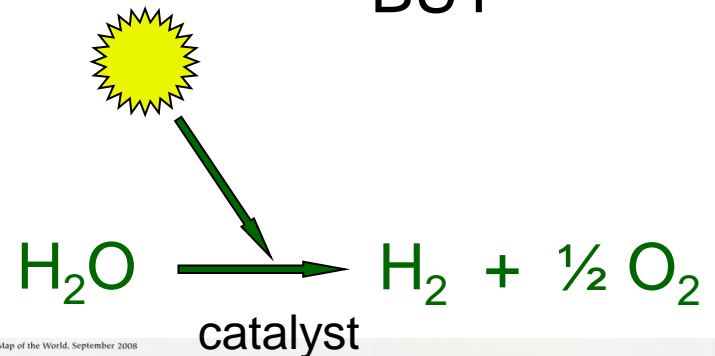
10-15 % CO₂



Source of hydrogen

- Currently from fossil fuels

BUT



Political Map of the World, September 2008



10% efficiency

Water splitting

6.9 %
efficiency

S. Y. Reece, J. A. Hamel, K. Sung, T. D. Jarvi, A. J. Esswein, J. J. H. Pijpers, D. G. Nocera, *Science*, 2011, **334**, 645

Conclusions

- CO₂ can make a significant contribution to chemicals production, reducing the carbon footprint
- In the longer term CO₂ could contribute to reducing carbon emissions from fuels
 - Need ways of collecting dilute CO₂
 - Need a sustained and efficient way of producing hydrogen from water using sunlight