Additional use of energy in the CCS capture process

Indicated additional energy use is shown in bold red.

IPCC A Special Report of Working Group III of the Intergovernmental Panel on Climate Change (2005) gives a range of **24-40%** for coal-fired power plants (Pulverized Coal plants).

IEA PROSPECTS FOR CO2 CAPTURE AND STORAGE (2004) **39%**

In an article by Kurt Zenz House, Charles F. Harvey, Michael J. Aziz and Daniel P. Schrag: The energy penalty of post-combustion CO2 capture & storage and its implications for retrofitting the U.S. installed base (January 2009) the authors conclude that additional energy use of retrofit CCS installations at coal power plants are in the range of **50-80%** and that this additional energy use in practice can not be brought below 25%.

"**Conclusion**
Achieving substantial reductions in CO2 emissions requires either shutting down a large fraction of the current installed base of coal-fired power plants or retrofitting those plants for CCS. Previous studies have estimated that the additional fuel required (*f2*) to maintain constant work output for a PC retrofit is between ~ **50% and 80%**. An Analysis of the Thermodynamic Limit indicates those values might be improved by harnessing more of the available waste heat and by improving the 2nd-law efficiency of temperature-swing separation system. It appears difficult, however, to improve *f2* for post-combustion capture to below 25% in practice. Our most likely efficiency scenario indicates that offsetting the energy penalty incurred from capturing and storing 80% of the U.S. coal fleet's CO2 emissions will require either an additional 390-600 million tonnes of coal, an additional 69-92 gigawatts of CO2-free-baseload power, or a 15% -20% reduction in overall electricity use."

A Panel Presentation (May 2007): CO2 Compression Opportunities in Fossil Fueled Power Plants. Session Chair: Richard Dennis and Manfred Klein states:

"When 90% CO2 capture is implemented in a precombustion decarbonization IGCC and CO2 is compressed to 2200 psia, the auxiliary power load increases by about **40%**, compared to the non-capture case. Over 50 % of this increase is due to CO2 compression. Reducing this power requirement will improve overall plant efficiency and encourage CO2 sequestration at both existing and future power plants."

In an abstract of the article Carbon Capture and Storage: Fundamental Thermodynamics and current technology by SC Page, AG Williamson and IG Mason the following is stated:

"Carbon capture and storage (CCS) is considered a leading technology for reducing CO2 emissions from fossil-fuelled electricity generation plants and could permit the continued use of coal and gas whilst meeting greenhouse gas targets. However considerable energy is required for the capture, compression, transportation and storage steps involved. In this paper, energy penalty information in the literature is reviewed, and thermodynamically ideal and ''Real World'' energy penalty values are calculated. For a sub-critical pulverized coal (PC) plant, the energy penalty values for 100% capture are **48.6%** and **43.5%** of liquefied CO2, and CO2 compressed to 11MPa, respectively. When assumptions of supercritical plants were incorporated, results were in broad agreement with published values arising from process modelling. However, we show that energy use in existing capture operation is considerably greater than indicated by most projections. Full CCS demonstration plants are now required to verify modelled energy penalty values. However, it appears unlikely that CCS will deliver significant CO2 reductions in a timely fashion. In addition, many uncertainties remain over the permanence of CO2 storage, either in geological formations, or beneath the ocean. We conclude that further investment in CCS should be seriously questioned by policy makers. "

Our preliminary conclusion

As it can be seen indications vary widely: from 24% to 80% depending on technology and other conditions. To have a starting point NOAH has chosen to assume an additional energy use in the capture stage of 40% which is what underlies examples and reviews on this website.