Effect of adding a refrigeration system - PUTARs* to existing power stations.

What we have at the moment

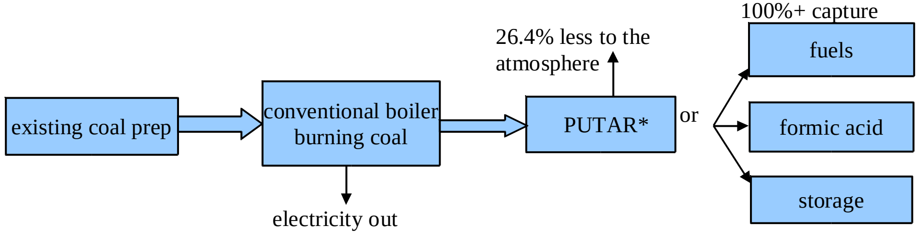
Existing brown coal power stations:

CO_2 produced per MWh - 1.44t

What we can get to by simply adding a PUTAR* system

Brown coal power stations with PUTAR* CO_2 capture:

CO_2 produced per MWh - 1.06t ± 0.14 (the higher + figure is for the worst implemented system and the lower – figure for very good heat recovery.)

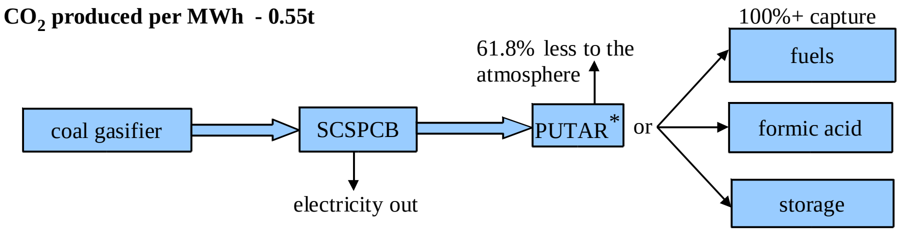


Nett result is that the CO_2 emissions are reduced by 26.4% ±9.7% just by putting in the PUTAR* for the same amount of coal used. The CO_2 can be "let go". The 100%+ reduction is obtained by one or a mix of processes to convert the CO_2:

i. conversion to fuels (diesel, kerosene, ethanol and/or methanol),
ii. conversion to formic acid,
iii. short term adsorption into carbon filter, or
iv. long term storage in sealed conditions at the bottom of the ocean.

Effect of adding PUTARs*, Pulse Pyrolisis & Super-critical-steam pulse combustion boilers (SCSPCB) to new power stations. (i.e. starting from scratch greenfield approach)

CO_2 produced per MWh - 0.55t



Nett result is that the CO_2 emissions are reduced by 61.8% (!) for the same amount of coal used. The 100%+ reduction is obtained as outlined above.

*PUTAR – This is a thermo-acoustic refrigerator driven by pulse combustion heaters with no moving parts, unlike compressor driven refrigeration systems. It operates by condensing out of the flue gas all gases condensable below 155°C in a sequential manner, such that the condensed gases are captured separately.

THE PUTAR EFFECT

What is a PUTAR? This is a thermo-acoustic refrigerator driven by pulse combustion heaters with no moving parts, unlike compressor driven refrigeration systems.

200t/day PUTAR

Heat is added at the top end via pulse combustion heaters and heat is also removed at the top end to set up a large temperature difference. The tubes themselves are filled with helium at 3MPa (30atm). The large temperature difference sets up an acoustic wave, which travels up and down the tubes with an amplitude of ± 0.3MPa. At the bottom of the tubes is an interconnected orifice that throttles the helium flowing through and thus cooling it. Temperatures down to -268°C are possible to obtain.

There are no moving parts in this refrigerator and hence the operating costs are very low. Because of the simplicity of the design, the capital cost are lower than conventional vapour compression refrigeration systems

The various gases that can be condensed out (this list is by no means complete) are:

Gas	Condensing temperature	Freezing point
H_2O	100.0°C	0°C
NO_2 *	21.2°C	-11.2°C
SO_2 *	-10°C	-73°C
H_2S *	-60.2°C	-86.0°C
CO_2	-65°C	-78.5°C
N_2O *	-88.5°C	-91.0°C
NO *	-152.0°C	-160.9°C

* - these gases are produced in negligible quantities from pulse combustion burners and can be ignored. The highest concentration is NO at ~1ppm.