	STATUS	TECHNOLOGY DESCRIPTION	DEMONSTRATION CAPACITY	COAL TYPE	SO_2 EFF.%	NOx EFF.%	PARTICULATES EFF, %	HAPs EFF.%	BOILER EFF. % CHANGE	NET HEAT RATE, EFF. % (note 21)	USABLE BYPRODUCTS	AVAILABILITY	TURNDOWN	DEMO BUDGET	PROJECTED CAPITAL (YEAR)	PROJECTED LEVELIZED $
ENVIRONMENTAL CONTROL DEVICES/SO_2																
10-MWe Demonstration of Gas Suspension Absorption	Complete	Flue gas desulfurization	10 MWe slipstream	Western KY bituminous 2.61 - 3.5% S	90+%		99.9+%	HCl=99+%; HF=99%; Most Trace Metals = 98+%			low grade cement	High - 100% for 28 day performance test		$7,717,189	$149/kW (1990$, note 1)	10.35mills/kWh (constant 1990$, note 1)
Confined Zone Dispersion FGD Demonstration	Complete	Flue gas desulfurization	73.5 MWe	PA bituminous 1.2 - 2.5% S	50+%									$10,411,600	<$30/kW (1994$, note2)	$300/ton SO_2 (1994$, note 2)
LIFAC Sorbent Injection Desulfurization	Complete	Flue gas desulfurization	60 MWe	Bituminous 2 - 2.8% S	70+%									$21,393,772	$66/kW (1994$, note3)	$65/ton SO_2 (1994$, note 4)
Advanced FGD Demonstration	Complete	Flue gas desulfurization	528 MWe	Bituminous 2 - 4.5% S	95+%			HCl=99%; HF=96% Most trace metals = 50 90+% (scrubber only)			gypsum	99.5%		$151,707,898	$101/kW (1995$, note 5)	7.2mills/kWh, $223/ton SO_2 (current 1995$, note 5)
Innovative Applications of Technology for CT-121 FGD	Complete	Flue gas desulfurization	100 MWe	Illinois No. 5 & 6 blend 2.4% S; compliance coal 1.2% S	90+%		97.7-99.3%	HCl and HF=95%; Most Trace Metals =80 98%			gypsum	95-97%		$43,074,996	$293/kW (1994$, note 6)	$357,000/yr fixed O&M costs, $34-64/ton SO_2 removed variable O&M costs (1994$, note 6)
ENVIRONMENTAL CONTROL DEVICES/NOx																
Micronized Coal Reburning	Complete	Micronized coal pulverization	148 MWe T-fired 6(MWe Cyclone	Pittsburgh bituminous 3.2% S T-fired 2.2% S Cyclone		29% T-fired 59% Cyclone			No Change				4.8:1 on reburn nozzles	$9,096,486	$14/kW T-fired $56/kW Cyclone (1999$, note 7)	$1,023/ton NOx (T-fired) $571/ton NOx (Cyclone) (constant 1999$, note 7)
Coal Reburning for Cyclone Boiler NOx Control	Complete	Coal reburning	100 MWe	Illinois bituminous 1.15% S/1.24% N; PRB 0.27% S / 0.55% N		>50%	No change	No change	-0.1 to -1.5%				66% from full load	$13,646,609	$43/kW (1990$, note 8)	1.5mills/kWh; $263/ton NOx (constant 1990$, note 8)
Full-Scale Low-NOx Cell Burner Retrofit	Complete	Low-NOx cell burners (LNCB)	605 MWe	Bituminous medium S		46.9-60%	No change	CO = 28 - 55 ppm	+0.16% avg.					$11,233,392	$9/kW (1994$, note 9)	0.284mills/kWh; $96.48/ton Nox (constant 1994$,note 9)
Gas Reburning and Low-NOx Burners on Wall-Fired Boiler	Complete	GR/LNB	172 MWe	Colorado bituminous 0.4% S/10% ash	SO_2 reduced by amount of gas used	65% avg	PM reduced by amount of gas used	CO_2=reduced; CO=acceptable	-1.0%					$17,807,258	$26/kW (1996$, note 10)	$95/ton SO_2, $786/ton NOx (constant 1996$, note 10)
SCR Technology for Control of NOx from High-Sulfur Coal	Complete	Selective catalytic reduction	8.7 MWe equiv.	Illinois bituminous 2.7% S		80+%								$23,299,729	$57/kW (1996$, note 11)	2.79 mills/kWh; $2,036/ton NOx (constant 1996$, note 11)
180 MWe Advanced T-Fired Combustion Techniques for Reduction of NOx	Complete	Low-NOx concentric firing system; advanced overfire air	180 MWe	Eastern bituminous		37 - 45%		no clear effect	-0.3% max	+0.36% max. (Baseline 9,995 to 10,031 Btu/kWh				$8,553,665	$15-$25/kW (1993$, note 12)	$400-444/ton NOx (constant 1993$, note 12)
Advanced Combustion Techniques for Wall-Fired Boiler	Complete	Low-NOx burners w/advanced overfire air & GNOCIS software	500 MWe	Eastern bituminous 1.7% S		68%		no significant diff.	-0.7%					$15,853,900	$19.3/kW (1995$, note13)	$79/ton NOx (1995$, note13)
ENVIRONMENTAL CONTROL DEVICES/COMBINED SO_2/NOx																
SNOX Flue Gas Cleaning	Complete	Catalytic, advanced flue gas cleanup	35 MWe equivalent	Ohio bituminous 3.4% S	95+%	94%	99+%	high			conc. H_2SO_4			$31,438,408	$305/kW (1995$, note 14)	6.1 mills/kWh; $219/ton SO_2 (constant 1995$, note 14)
LIMB Extension and Coolside Demo	Complete	Limestone Injection Multistage Burner (LIMB); Duct injection of lime sorbents (Coolside)	105 MWe	Ohio bituminous 1.6-3.8% S	45 - 61% LIMB 70% Coolside	40-50% LIMB						95% LIMB		$19,311,033	$40/kW LIMB $81/kW Coolside (1992$, note 15)	$392/ton SO_2 LIMB $482/ton SO_2 Coolside (1992$, note 15)
SOx-NOx-Rox-Box (SNRB) Flue Gas Cleanup	Complete	High-temperature baghouse, SCR, & sorbent injection	5 MWe equivalent	Bituminous blend 3.7% S	80-90%	90%	99.89%	HCl=95% HF=84%			Agricultural lime or partial cement replacement			$13,271,620	$253/kW (1994$, note16)	$553/ton SO_2 & NOx (constant 1994$, note 16)
Gas Reburning and Sorbent Injection	Complete	Gas reburn with sorbent injection	80 MWe T-fired 40 MWe cyclone	Illinois bituminous 3.0% S (both)	53% avg T-fired 58% avg cyclone	67% avg T-fired 66%avg cyclone	99.8% T-fired		approx. -1.0%					$37,588,955	$65/kW (1996$, note 17)	$300/ton SO_2 (1996$, note 17)
Milliken Clean Coal Technology	Complete	Formic-acid-enhanced wet limestone scrubber; low-NOX concentric firing system; tile-lined split-module absorber; air preheater; PEOA control system	300 MWe	Pittsburgh, Freeport and Kittanning 1.5-4.0% S	80-98%	29 - 39%	99.88% w/ modified ESP (99.78% prior to project)		approx. -1.0%		Gypsum	99.9% (FGD system)		$158,607,807	$300/kW (1998$, note 18)	$412/ton of SO_2 removed (constant 1998$, note 18)
Integrated Dry NOx/SO_2 Emissions Control	Complete	Low-NOx burners; in-duct sorbent injection; furnace urea injection	100 MWe	Colorado bituminous 0.4% S	40 - 70%	80+%		Hg=80%; Trace Metals=nearly all				91+%		$26,165,306	$125/kW (1994$, note 19)	987$/ton of SO_2 & NOx removed
ADVANCED ELECTRIC POWER GENERATION/FBC																
McIntosh Unit 4A PCFB	On hold	Pressurized circulating fluidized bed combustor; hot gas particulate filter system	137 MWe net	Eastern KY and high ash, high S bituminous	95% (design)	0.3#/MMBtu (outle design)	0.03#/MMBtu (outlet design)			9,480 Btu/kWh (HHV)	potential solids			$186,588,000		
McIntosh Unit 4B Topped PCFB	On hold	Multi-annular swirl-burner topping combustor (addition to Unit 4A)	103 MWe net addition to 137 MWe McIntosh 4A project	Eastern KY and high ash, high S bituminous	95% (design)	0.17#/MMBtu (outlet design)	0.02#/MMBtu (outlet design)			7,500 Btu/kWh (HHV)	potential solids			$219,635,546		
JEA Large Scale CFB Combustion	Start-up	Atmospheric circulating fluidized-bed combustor	298 MWe gross	Eastern bituminous 0.7% S	98% (design)	0.09#/MMBtu (outlet design)	0.011#/MMBtu (outlet design)			9,950 Btu/kWh 34%				$309,096,512		
Tidd PFBC	Complete	Pressurized fluidized bed combustor	70 MWe	Ohio bituminous 2-4% S	90-95%	0.15-0.33 #/ MMBtu	<0.02#/MMBtu	CO=0.01#/MMBtu		10,280 Btu/kWh 33.2%				$189,886,339	$1,263/kW (1997$, note 20)	
Nucla CFB	Complete	Atmospheric circulating fluidized-bed cumbustor	100 MWe net	Western bituminous 0.5-1.5% S / 17-23% ash	70 - 95%	0.18#/MMBtu avg.	99.9+%	CO=70-140 ppmv		11,600 Btu/kWh	potential solids fill	97%	3:1	$160,049,949	$1,123/kW (1988$, note 21)	64 mills/kWh (note 21)
ADVANCED ELECTRIC POWER GENERATION/IGCC																
Kentucky Pioneer IGCC	Design	Integrated gasification combined-cycle slagging fixed bed gasification system; molten carbonate fuel cell	580 MWe gross (IGCC) 2.0 MWe (fuel cell)	KY bituminous (high sulfur) and refuse derived fuel (RDF)	<0.1#/MMBtu expected	<0.15#/MMBtu expected		CO_2>20% reduction from conventional		8,560 Btu/kWh 40%	slag, sulfur			$431,932,714		
Pinon Pine IGCC	Complete	Integrated gasification combined-cycle w/air-blown pressurized fluidized-bed gasification	107 MWe gross	Southern Utah bituminous 0.5-0.9% S	95+% expected	70% less than conventional plant expected		CO_2>20% reduction from conventional		7,800 Btu/kWh 43.7% (projected for greenfield site)				$335,913,000		
Tampa Electric IGCC	Operating	Integrated gasification combined-cycle pressurized oxygen-blown entrained-flow gasifier with acid gas cleanup	316 MWe gross	Illinois #6, Pittsburgh #8 and KY #9 and 11 2.5 3.5% S	<0.15#/MMBtu	<0.27#/MMBtu				9,350 Btu/kWh (HHV)	H_2SO_4; slag	Gasifier >83.5% (6-month period); combined-cycle 94%		$303,288,446		
Wabash River Coal Gasification Repowering	Complete	Integrated gasification combined-cycle 2-stage pressurized oxygen-blown entrained flow gasification system	296 MWe gross	Illinois bituminous up to 5.9% S	<0.1#/MMBtu (99% capture)	0.15#/MMBtu	<0.012#/MMBtu for PM10	CO_2~20% reduction from conventional		8,910 Btu/kWh (HHV)	sulfur, slag	79.1% in 1999		$438,200,000	$1,250/kW (2000$, Note 22)	
ADVANCED ELECTRIC POWER/COMBUSTION/HEAT ENGINES																
Healy Clean Coal	Complete	Entrained slagging combustor; spray dryer absorber w/ recycle	50 MWe nominal	Usibelli, AK subbituminous 50% Waste coal 50% (<0.2% S)	0.038#/MMBtu (90+% capture)	0.245#/MMBtu typical	0.0047#/MMBtu typical (2 6% opacity)	CO 30 - 40 ppm typical	82.2% actual	12,500 Btu/kWh at full load	none	94.8% for 90 day test run		$242,058,000	$1,318/kW (2000$, note 23)	36.5 mills/kWh (constant 2000$, note 23)
Clean Coal Diesel Demonstration	Operating	Coal-fueled diesel engine	6.4 MWe net	Usibelli AK subbituminous 0.1 - 0.5% S	50-70% below NSPS estimated	50-70% below NSPS estimated		CO_2 est. 25% reduction from conventional		41%				$47,636,000	$1,300/kW est. for mature commercial unit	
COAL PROCESSING FOR CLEAN FUELS																
Liquid-Phase Methanol (LPMEOH) Process	Operating	Methanol and dimethyl ether synthesis reactor	80,000 gallons MeOH/day	Eastern bituminous 3-5% S							MeOH/DME (dimethyl ether)	>99% (1998 - 2000)	2.2:1	$213,700,000	$28.3 million (note 24)	$0.483/gallon (note 24)
Advanced Coal Conversion Process	Operating	Thermal coal conversion and physical cleaning to produce SynCoal	45 tph SynCoal	PRB 0.5-1.5% S plus other subbituminous and lignites	8% reduction SO_2	19% reduction	Minimal reduction in coal ash content		Increased 4% using Syncoal	Improved by 123 Btu/kWh using Syncoal				$105,700,000		
Development of the Coal Quality Expert	Complete	Coal quality expert computer software	250-880 MWe (6 diff. test sites)	Wide variety										$21,746,004		
ENCOAL Mild Coal Gasification	Complete	Liquids-from-coal process	1,000 tpd feed coal	PRB 0.45% S	solid fuel S content reduced 20% (note 15)	20% reduction from base burn		No listed toxins even close to Federal limits		PDF heating value 34% greater than feed coal	Coal derived liquid (note 15)	90% for extended periods		$90,664,000	$475MM (2001$, note 25)	$52MM/year O&M costs (2001$, note 25)
INDUSTRIAL APPLICATIONS																
Blast Furnace Granular-Coal Injection System	Complete	Direct granular coal injection	7,000 net tons hot metal (NTHM) and 2800 tons feed coal per day	VA Pocahontas/ Buchanan/Oxbow 0.76% S	note 16	note 16	note 16	note 16						$194,301,790	$15,073,106 (1990$, note 26)	Fixed and variable operating costs of $9.81/ton of coal (1990$, note 26)
Clean Power from Integrated Coal/Ore Reduction (CPICOR)	Design	Iron-making & electricity coproduction	3,300 tpd liquid Fe; 277 MWe (gross)	Bituminous 0.5% S										$1,065,805,000		
Pulse Combustor Design Qualification Test	Complete except reporting	Steam reforming using multiple resonance tube pulse combustor	30 MMBtu/hr steam reformer	PRB (Black Thunder)										$8,612,054		
Advanced Cyclone Combustor with Internal S, N_2 and Ash Control	Complete	Air-cooled slagging combustor	30 MMBtu/hr design; 20 MMBtu/hr operating	PA bituminous 1.0-3.3% S	up to 58% (combustor); >80% (furnace)	75-85%	55 - 90% 72% avg. ash retention	slag essentially inert			slag		3:1	$984,394	$100-200/kW (1991$, note 27)	
Cement Kiln Flue Gas Recovery Scrubber	Complete	Waste recovery scrubber	1,450 tpd cement; 250,000 scfm kiln gas; 274 tpd coal	PA bituminous 2.5-3% S	94.6% end-run avg. and 89.2% for entire period	25% end-run avg. and 18.8% for entire period	85% removal 0.005 0.007 gr/scf discharge	HCl=98%(pilot test); VOC=76.6% avg.; CO_2=2% reduction			cement kiln dust (CKD) feedstock fertilizer	99.5% in July 1993		$17,800,000	$10,090,000 (1990$, note 28)	$500,000/yr O&M (1990$, note 28)

NOTES:

1. Assumes three GSA units at 50% capacity, installed in a 300 MWe plant using 2.6% sulfur coal, 90% removal efficiency and Ca:SO_2 at 1.3:1 (v/v) over 15 year span.
2. Assumes 500 MWe unit burning 4%S in coal, at 50% SO_2 capture.
3. Assumes two LIFAC reactors at 150 MW each ($76/kW for one @ 150 MW, and $99/kW for one @ 65 MW).
4. Assumes 75% SO_2 removal with a Ca/S molar ratio of 2.0, using 95% $CaCO_3$ at $15/ton limestone.
5. Assumes 500 MWe unit burning 4.5% S in coal, at 90% SO_2 removal efficiency and 65% plant capacity factor.
6. Actual capital and O&M costs for 100 MWe demonstration plant
7. Retrofit of 300 MWe boiler (T-fired and cyclone), levelized over 15 years
8. Assumes 605 MWe unit over 30 years and no change in O&M costs.
9. Assumes 600 MWe plant in Midwest with initial NOx emissions of 1.2 lb/10^6Btu, a 65% capacity factor, 50% reduction target and levelized over 15 years
10. Assumes 300 MWe unit, natural gas line is existing, $1.00/$10^6$Btu fuel cost differential, and SO_2 allowance value of $95/ton (1996$)
11. Assumes greenfield 250 MWe unit with inlet NOx of 0.35 lb/10^6Btu and 80% NOx removal.
12. Based on actual costs of demonstration and other projects for LNCFS II and III
13. Assumes 500 MWe unit and 68% NOx reduction
14. Assumes 500 MWe unit burning 3.2% S coal levelized over 15 years
15. Assumes 500 Mwe unit burning 3.5% S coal
16. Assumes 150 MWe unit burning 3.5% S coal with initial NOx inlet of 1.2 lb/106 Btu, 65% capacity factor, 85% SO_2 removal and 90% NOx removal
17. Assumes 100 MWe unit at 60% NOx reduction, with 15% gas heat input. Does not include gas pipeline installation. $300/ton SO_2 is for Sorbent Injection (SI) only.
18. Assumes 300 MWe unit with 65% capacity factor, 3.2% S coal, 95% sulfur removal and levelized over 15 years
19. Assumes 300 MWe plant, 0.4% S coal, 70% SO_2 removal and 79% NOx removal
20. Based on cost estimate for similar technology on a 360 MWe unit in Japan.
21. Based on actual demonstration project costs. Normalized costs of power production cover September 1988 through January 1991 operation
22. Based on greenfield facility with heat rate of 8,250 Btu/kWh using coal
23. Based on 300 Mwe plant with 90% capacity factor, 0.4% S coal, and 15 year book life
24. Assumes 500 sT/D methanol plant, an existing source of syngas and fuel-grade product
25. Based on 15,000 metric tons/day plant
26. Actual costs for one complete injection system for 7,200 net tons of hot metal/day blast furnace
27. Estimated incremental capital cost to install the coal combustor in lieu of oil or gas systems
28. Assumes a flue gas recovery system for a 450,000 tpy wet processing plant, O&M costs exclude capital and interest costs, and O&M costs are generally offset by avoided fuel, feedstock and waste disposal costs plus fertilizer revenues