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Series/Staff Member: Roger Ballentine; Paul Bledsoe; Julie Anderson
Subseries:

OA/ID Number: 41302
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Folder Title:
Clean Coal [1]

Stack:	Row:	Section:	Shelf:	Position:
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**COAL
UTILIZATION
RESEARCH
COUNCIL**

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Power Generation
American Electric Power

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Executive Director

Ben Yamagata

February 12, 1999

Julie Anderson
Director of Congressional Relations
White House Climate Change Task Force
734 Jackson Place, NW
Washington, D.C. 20503

Dear Julie:

Thank you for taking the time to meet with CURC representatives on Wednesday. The members of CURC have invested a great deal of time and effort to define ways that government and industry might work together to insure the development of technologies that will dramatically improve the conversion or combustion of coal to useful energy.

We appreciate your interest with our current and future plans to ensure that coal remains a viable energy resource in the marketplace and, we would welcome any further input or advice you might have regarding our initiatives to insure that coal remains a viable energy resource in the U.S. and abroad.

Thank you again for taking the time to meet with us. We look forward to continuing dialogue with your offices about these matters.

Sincerely,



Ben Yamagata
Executive Director

1050 Thomas Jefferson St., NW
Suite 700
Washington, DC 20007

(202) 298-1850
(202) 338-2416 FAX

CURC@VNF.COM

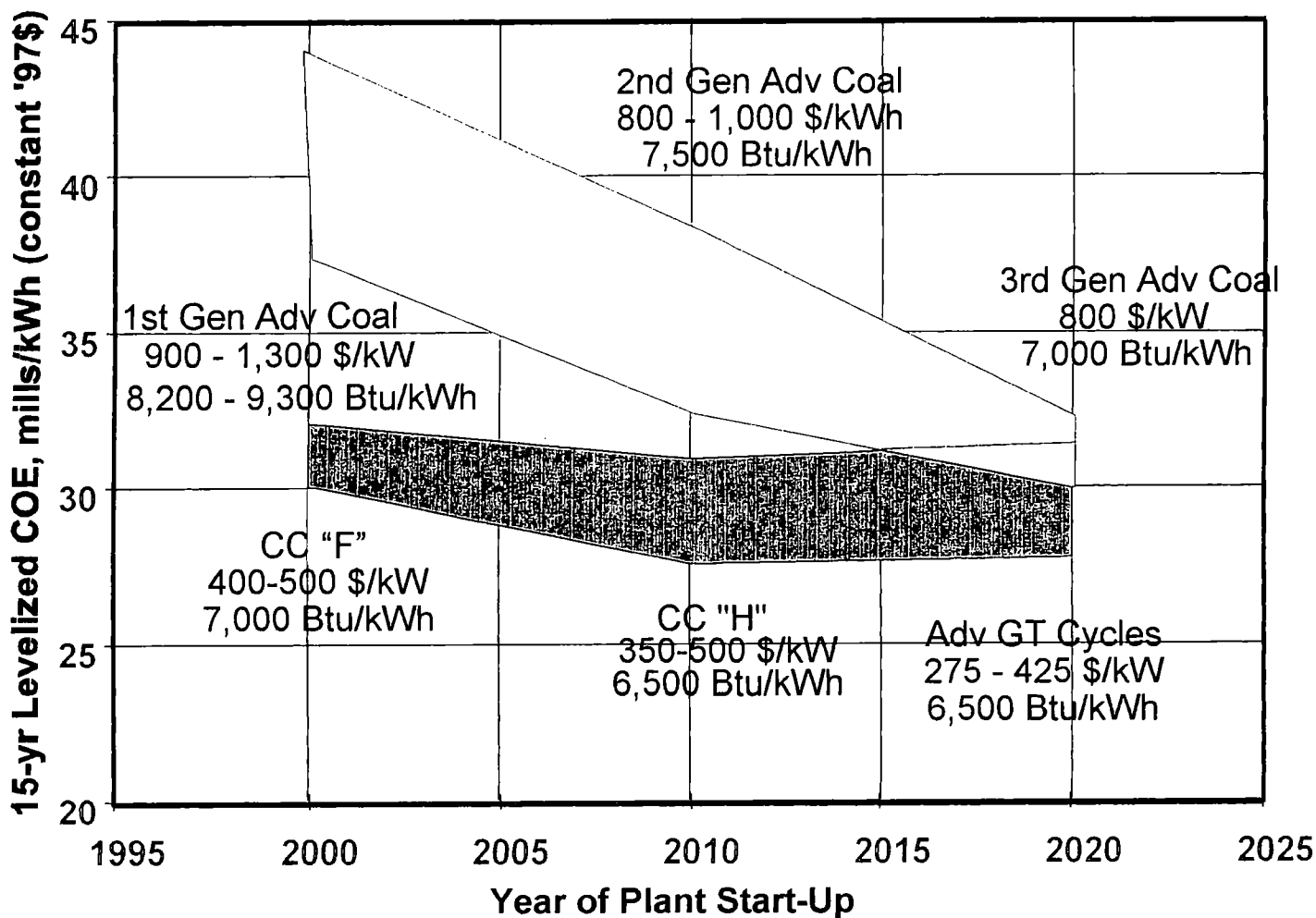
written
~~John~~
-314-342-7560

Clean Coal Technology Budget and Tax Incentives Meeting

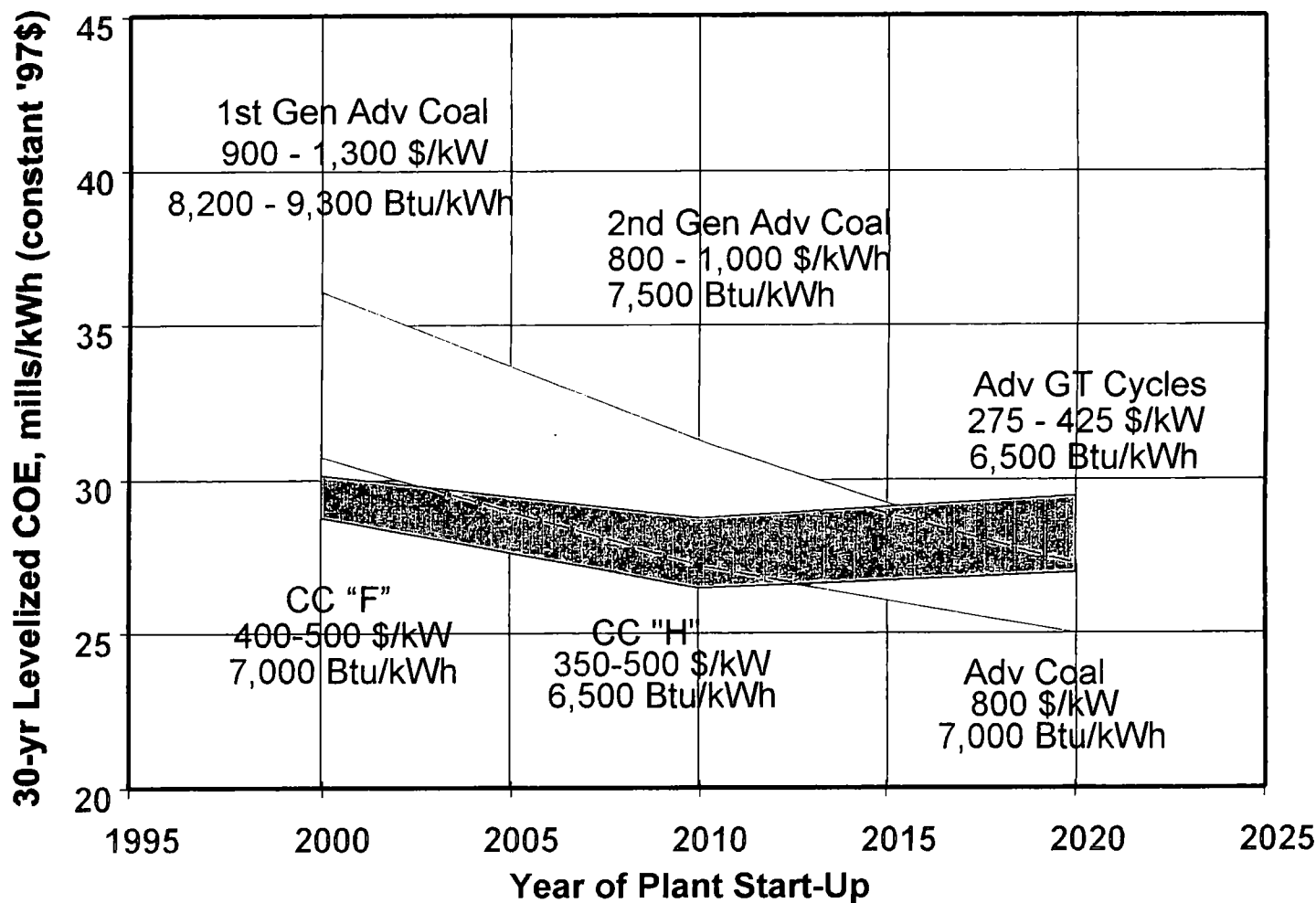
February 10, 1999
SC-4 The Capitol
2:00 - 3:30 p.m.

- | | |
|--|---|
| I. Welcome & Introductions | Franz Wuerfmannsdobler
Office of Senator Byrd |
| II. FY 2000 R&D budget & incentives package for coal | Todd Stern - White House &
Bob Kripowicz - DOE |
| III. Energy challenges & fuel diversity | Charles Goodman
Southern Company |
| IV. CURC's R&D Roadmap
-- Industry reaction to DOE's initiatives | Ben Yamagata
CURC |
| V. Incentives for early commercial application of CCT
-- CCT tax incentives
-- Revenue requirements
-- International options
-- Carbon sequestration potential | John Wootten
Peabody Group |
| VI. Q & A / Discussion | Franz Wuerfmannsdobler
Office of Senator Byrd |
| VII. Future activities | All |

15-Year Levelized Cost of Electricity for Coal Fired v. Gas Fired Power Technologies



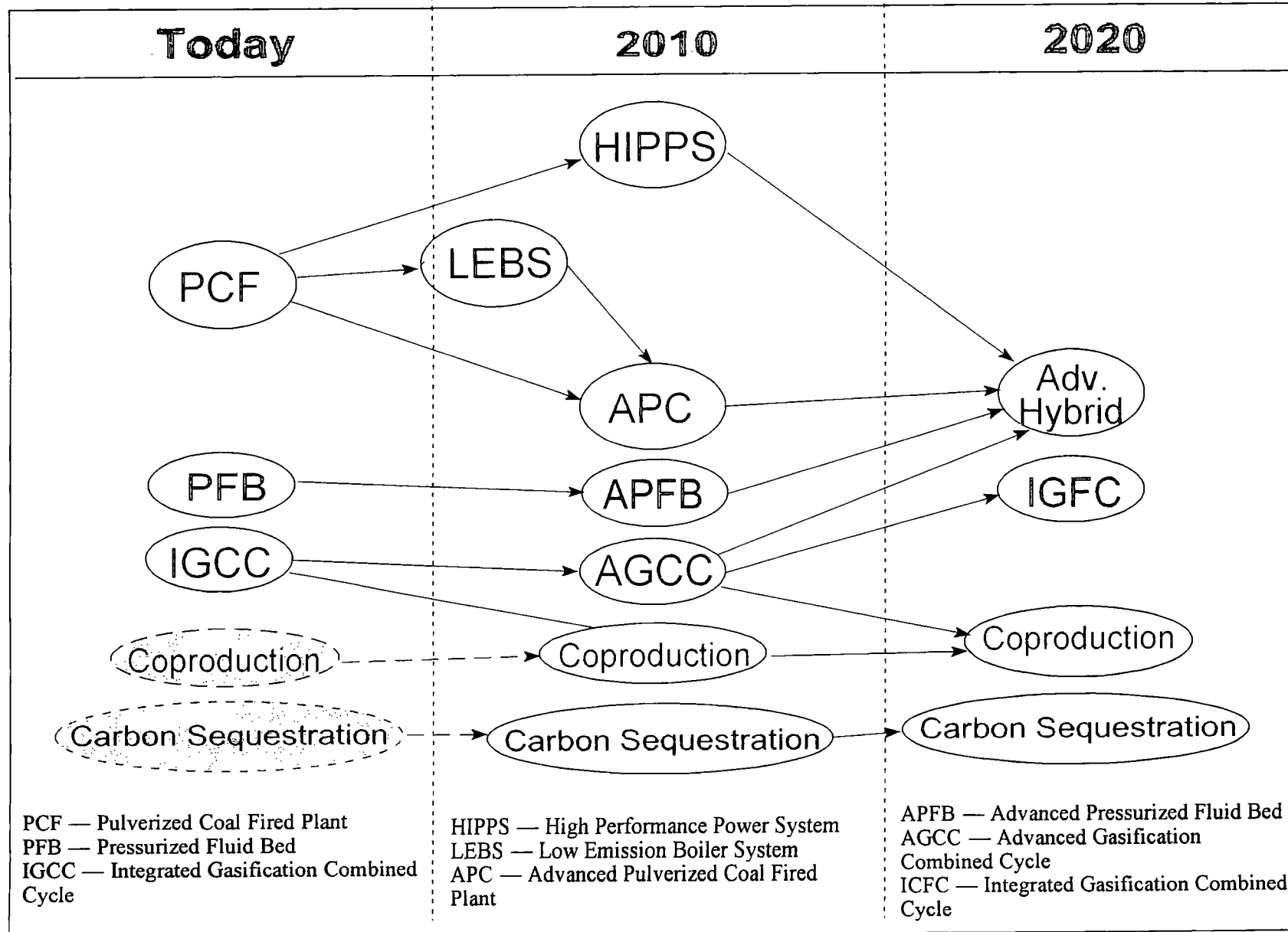
30-Year Levelized Cost of Electricity for Coal Fired vs. Gas Fired Power Technologies



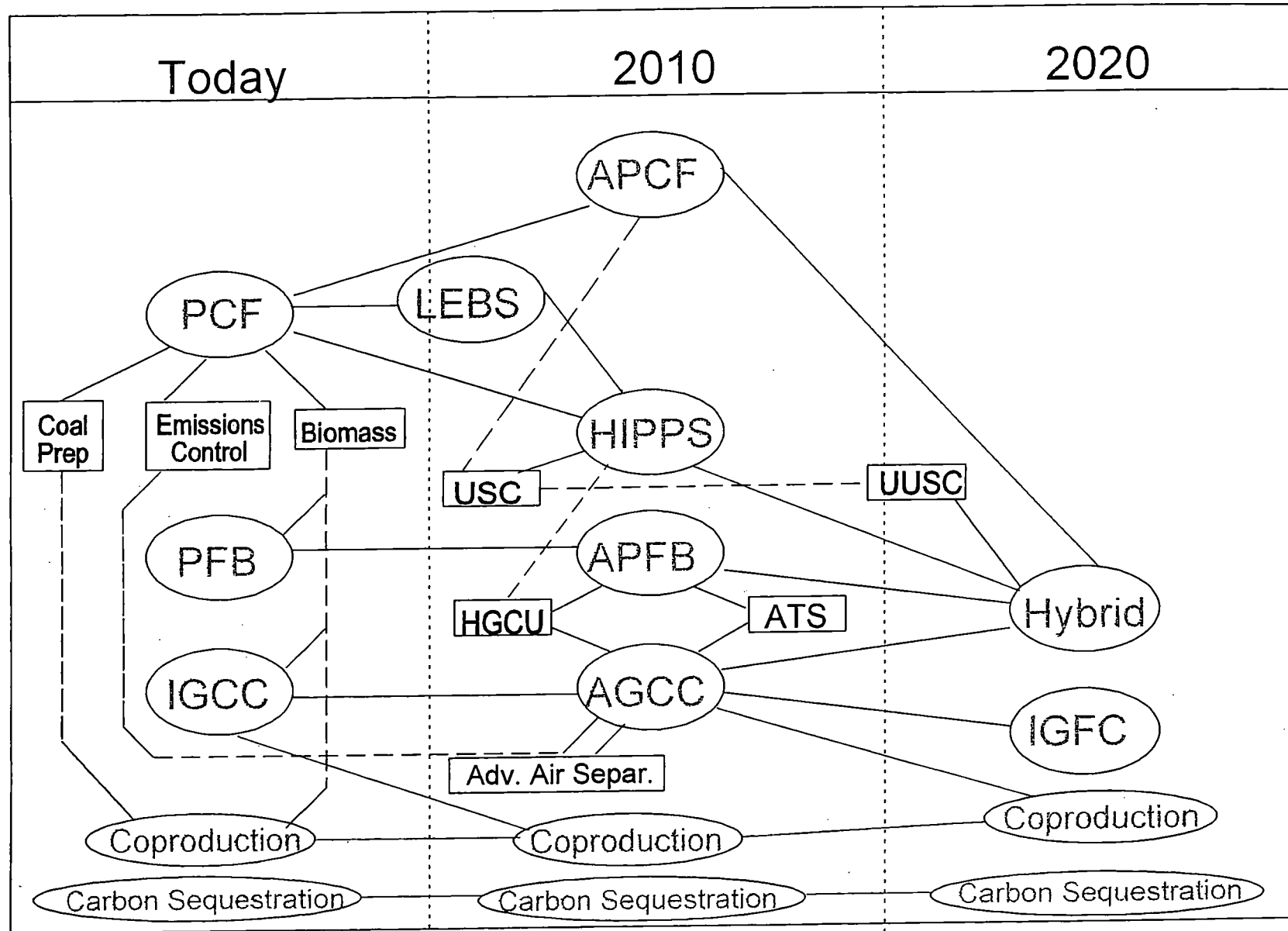
Performance Targets for Coal Generation

Performance Target	Today	2010	2020
Capital Cost, \$/kW	900 - 1300	800	800
Efficiency, %HHV	40	45	50 - 60
SO₂, removal %	95	97	99
No_x lbs/mmbtu	0.1 - 0.3	0.08	0.05
HAPs (<i>hazardous air pollutants</i>)	define goals	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100
Overall Emissions		Significant Reductions from Today's Technology	Deminimis Emissions

Coal Fired Power Plant Technologies



Coal Fired Power Plants / Enabling Technologies



Enabling technologies to build industry core competencies include materials and lifting; sensors and controls; computational fluid dynamics; coal characterization; and coal preparation.

Efficiency Goals for Coal Fired Plants

Year 2010 Goal

Year 2020 Goal

LEBS

APCF

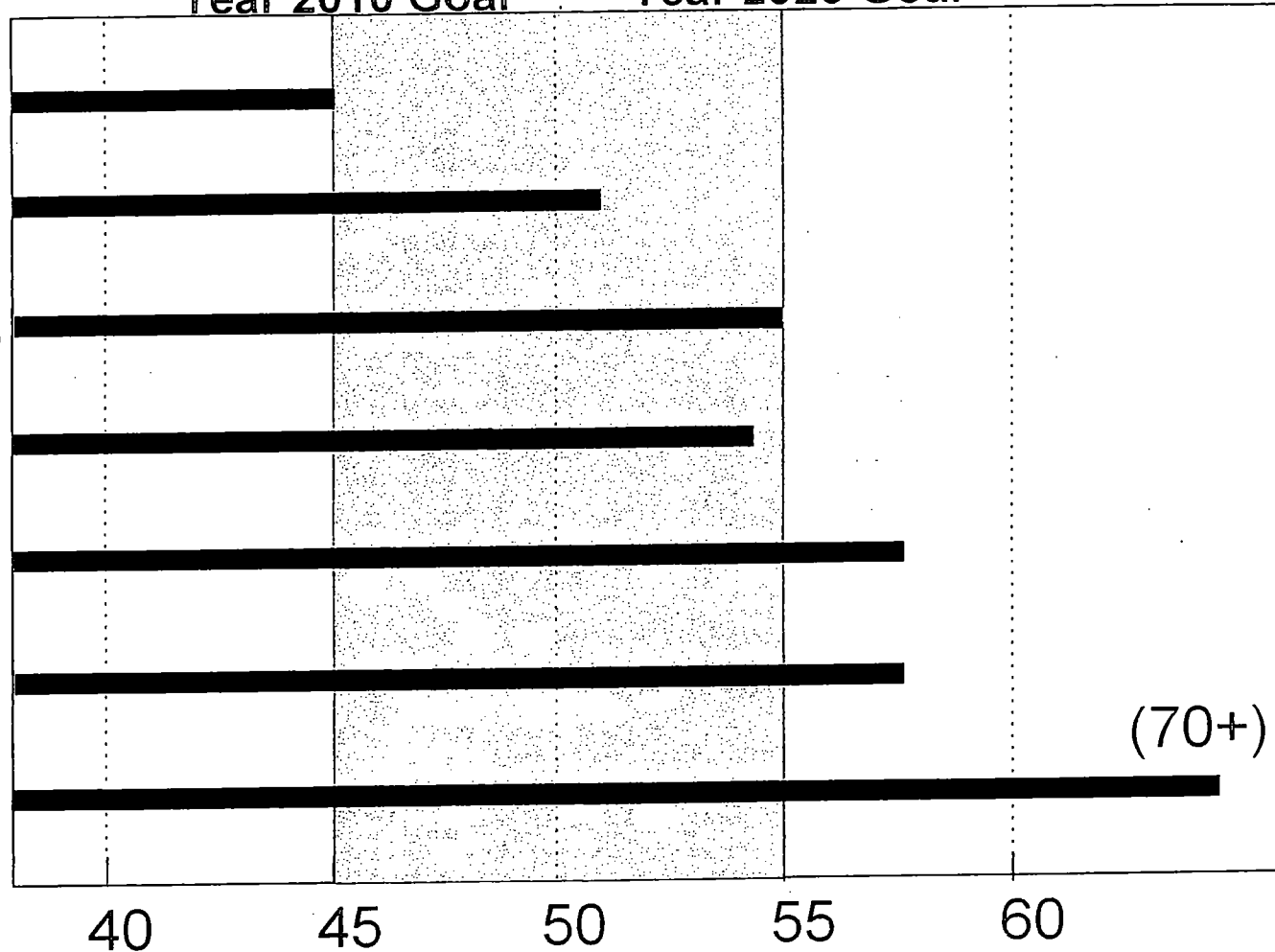
HIPPS

APFB

AGCC

Hybrid

IGFC



(70+)

Efficiency, %HHV

AGCC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	1200-1300	800	800
Efficiency, %HHV	40	45	57*
SO ₂ removal, %	99 (cold)	97 (hot)	99 (hot)
NO _x lbs/mmbtu	0.06	0.06	0.05
HAPs	define goals	meet goals	meet goals
Waste Utilization, %	30	75	100
Equivalent Availability, %	90	90	90

*GCC/PFB Hybrid

AGCC Technology Trajectories

Technology Need	Today	2010	2020
Gas Cleanup	cold	hot -- 1000 °F 8,000-20,000 hrs by 2005	hot -1500 °F 20,000 hours
Combustion Turbine	"F" 2350 °F	ATS -- 2750 °F plus combustor development	Advanced CT cycles
Steam Cycle	Subcritical	Subcritical	Ultrasupercritical Steam
Oxidant	O ₂	Air or O ₂ with advanced air separation	Air or O ₂ with advanced air separation
SO ₂ removal	cold	hot with external desulfurization	hot
Waste Utilization, %	15 - 30	50 - 75	100

APFBC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	900 -1100	800	800
Efficiency, % HHV	40	45	57*
SO ₂ removal, %	95	97	99
NO _x , lbs/mmbtu	0.1	0.08	0.05
Equivalent Availability, %	90	90	90

* GCC/PFB Hybrid

APFBC Technology Trajectories

Technology Need	Today	2010	2020
HTHP Filters	Cyclones	1600°F oxidizing conditions	1700°F oxidizing conditions
Combustion Turbine	"F"- 2350°F rugged	ATS-- 2750°F advanced combustor	Advanced CT cycles
Steam Cycle	2400psi/1050°F single reheat	3500psi/1050°F single reheat	5000psi/1300°F double reheat
Sulfur removal	dolomite	flue gas polishing	flue gas polishing
HAPs	define goals (trace)	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100

IGFC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	n/a	n/a	800+
Efficiency, %HHV	n/a	n/a	70+
SO ₂ removal, %	n/a	n/a	99+
NO _x , lbs/mmbtu	n/a	n/a	< 0.05
HAPs	n/a	n/a	meet goals
Waste Utilization, %	n/a	n/a	100
Equivalent Availability %	n/a	n/a	90

IGFC Technology Trajectories

Technology Need	Today	2010	2020
Fuel Utilization	natural gas fuel cells	coal gas fuel cells	large coal gas fuel cells
Plant Scale-Up	250kw to 1MW demos	2 to 50MW demos	200-400MW commercial plants
Hot Gas Clean-Up	see GCC	see GCC	as required to maintain fuel cell life
SO ₂ removal	see GCC	see GCC	as required to maintain fuel cell life
Integration	n/a	CT/Fuel Cell Integration	integration of gasifier hot-gas clean-up, and fuel cell

HIPPS Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	n/a	800	800
Efficiency, %HHV	n/a	47	55
SO ₂ removal, %	n/a	99	99
NO _x , lbs/mmbtu	n/a	0.06	0.05
HAPs	n/a	meet goals	meet goals
Waste Utilization, %	n/a	some	100
Equivalent Availability, %	n/a	90	90

HIPPS Technology Trajectories

Technology Need	Today	2010	2020
High Temperature / High Pressure Filter	n/a	1100°F reducing	1800°F reducing
Heat Exchanger	n/a	1800°F (Alloy)	2750°F (ceramic)
Steam Cycle	n/a	4000psi/ 1200°F double reheat	5000psi/ 1300°F double reheat
Steam Turbine	n/a	cycle design, aerodynamics, materials	cycle design, aerodynamics, materials
Gas Turbine	n/a	Humid air turbine	Humid air turbine 2750°
Particulate	n/a	to be defined	to be defined

Advanced PC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	1100	800	800
Efficiency, % HHV	41	45	47-51
SO ₂ removal, %	97	98	99
NO _x , lbs/mmbtu	0.1	0.08	0.05
HAPs	define goals	mercury control	meet goals
Waste Utilization, %	15 - 30	50 - 75	100
Equivalent Availability, %	90	90	90

Advanced PC Technology Trajectories

Technology Need	Today	2010	2020
Steam Cycle Conditions	3500 psi/1050°F Double reheat	4000 psi/1200°F Double reheat	5000 psi/1300°F Double reheat
Boiler and Steam Cycle Materials	ferritics, austenitics	ferritics, austenitics, Ni-based alloys	new Ni-based alloys
Steam Turbine	n/a	plant cycle integration, materials	new aerodynamics, cycle integration, materials
SO₂ removal	n/a	integrated with HAPS & particulate control	integrated with HAPS & particulate control
NO_x control	burners, SCR	Adv. burners, SCR	Adv. burners, SCR

Crosscutting Enabling Technology

Technology	2010	2020
High Temperature/ High Pressure Filters		
AGCC	1000°F reducing	1500°F reducing
APFB	1600°F reducing	1700°F reducing
HIPPS	1100°F reducing	1500°F reducing
IGFC	n/a	1000°F reducing
Combustion Turbine		
AGCC	2750°F — ATS	Advanced Cycle
APFB	2750°F — ATS	Advanced Cycle
HIPPS	n/a	2750°F
Steam Cycle Materials		
APFB	n/a	New Alloys, 1300°F
APC	Ferritics, new alloys	New Alloys, 1300°F
HIPPS	n/a	New Alloys, 1300°F
HAPS	Address issues as characterized by 2000 for all technologies	Address

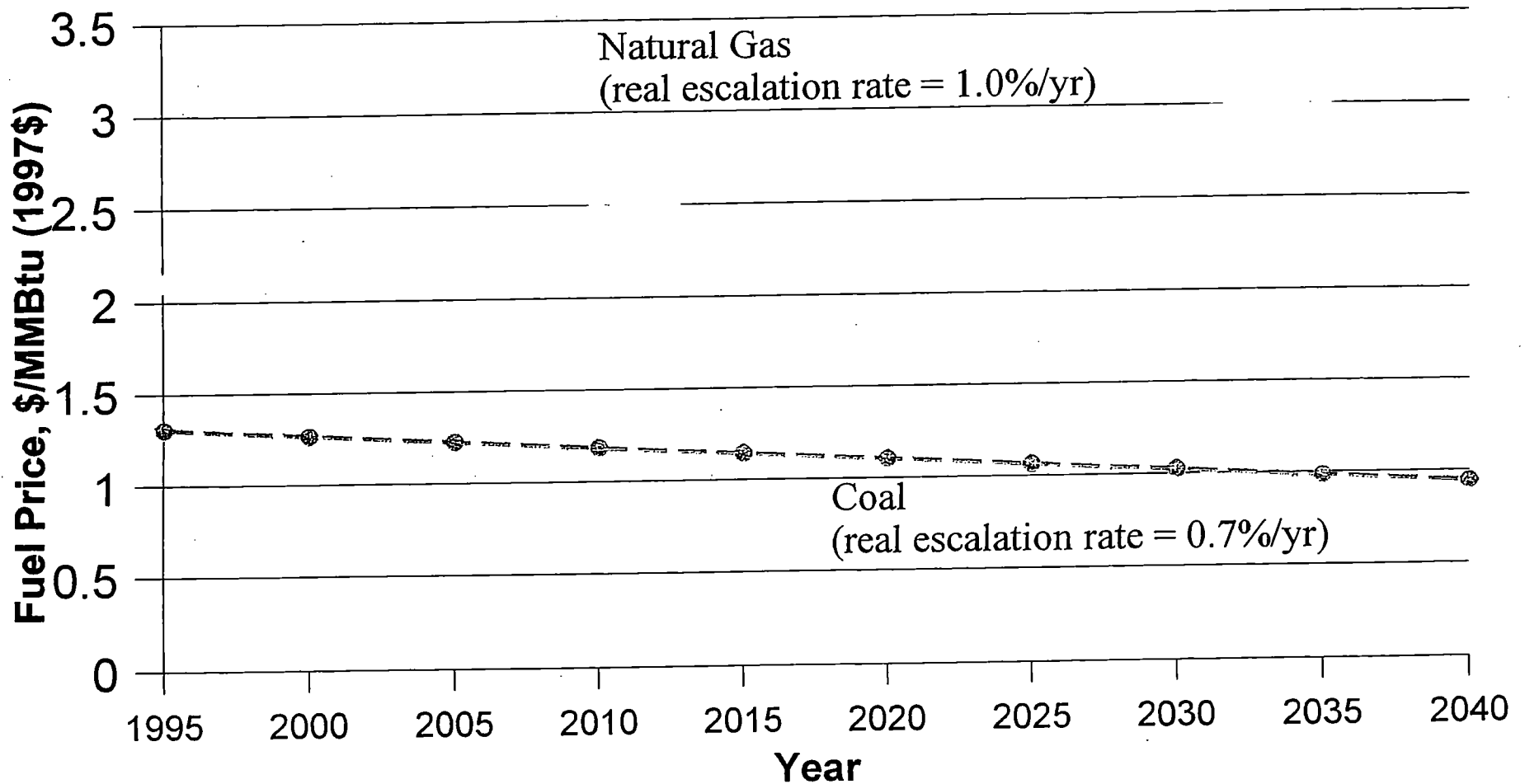
Crosscutting Enabling Technology

Technology	2010	2020
Hot Sulfur Cleanup		
AGCC	External Hot Desulfurization	External Hot Desulfurization
APFB	n/a	Polishing
IGFC	n/a	External Hot Desulfurization Polishing
NOx Removal		
AGCC	n/a	n/a
APFB	n/a	n/a
IGFC	n/a	n/a
HIPPS	Advanced Cost Efficient NOx Removal	Advanced Cost Efficient NOx Removal
Air Separation		
AGCC	Advanced Air Separation	Advanced Air Separation
APFB	Advanced Air Separation	Advanced Air Separation
IGFC	Advanced Air Separation	Advanced Air Separation
HIPPS	n/a	n/a

Assumptions Used to Determine COE in Comparison Charts

Region	SE	SE	SE	SE	SE	SE	SE	SE
Technology	Adv PFBC	Adv IGCC	IGCC "F"	IGCC "H"	IGCHAT	CC "F"	CC "H"	Adv CHAT
Plant Size, MW	680	460	570	450	450	225	400	400
Capacity Factor, %	85	85	85	85	85	85	85	85
Fuel	Coal	Coal	Coal	Coal	Coal	Gas	Gas	Gas
Fuel Cost in yr 2000, \$MMBtu	1.29	1.29	1.29	1.29	1.29	2.24	2.24	2.24
Fuel Real Esc. Rate, %/yr	-0.07	-0.07	-0.07	-0.07	-0.07	1	1	1
Total Plant Cost, \$/kW	800	800	1310	1150	810	400	350	270
Fixed O&M, \$/kW-yr	26.9	35.4	43.8	38.4	35.4	13.3	10.3	10.3
Var. O&M, mills/kWh	2	1.5	1.3	1.3	1.5	3.1	2.2	2.2
Heat Rate, Btu/kWh HHV	7240	7000	8200	7500	7000	7000	6500	6500
<p>Note: Total Plant Costs are typical values. They vary depending on plant size and design, plant location, etc.</p> <p>Fuel Costs are based on EIA's 1997 AEO Projections (National Average)</p>								

Fuel Price Projections Based on AEO '97



Natural Gas Coal

Glossary of Acronyms

ATS	Advanced (gas) turbine system
AGCC	Advanced gasification combined cycle
APCF	Advanced pulverized Coal fired plant
APFB	Advanced pressurized fluid bed
CC	Combined cycle
HAPs	Hazardous air pollutants
HIPPS	High performance power system
HGCU	Hot gas cleanup
HHV	Higher heating value
IGCC	Integrated gasification combined cycle
IGFC	Integrated gasification fuel cell
LEBS	Low emission boiler system
PCF	Pulverized coal fired plant
PFB	Pressurized fluid bed
USC	Ultra supercritical
UUSC	Ultra, ultra supercritical



DEPARTMENT OF THE TREASURY
OFFICE OF TAX ANALYSIS
1500 PENNSYLVANIA AVENUE, NW
WASHINGTON, DC 20220

Number of pages to follow: 2

Date: September 18, 1998

To: Julie Anderson

Fax: 395-2342

From: Len Burman
Tel: (202) 622-0120

Comments:

I've attached talking points on the clean coal technology proposal. The proposal raises serious concerns: 1. As currently crafted it can increase emissions in the US depending on the plants that are replaced; 2. For overseas investments, the incentives may be ineffective or overly generous, depending upon how they are structured; 3. The incentives are overly generous in relation to operating costs, the value of output or the potential environmental benefits.

If we pursue a proposal fashioned after this one, it would be preferable to reduce the incentives provided and restrict them to domestic CCT investments that replace conventional coal plants.

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Tax Incentives for Clean Coal Technologies (Document dated May 1998)

The proposal would provide the following incentives for investments in qualifying clean coal technology (CCT) installed in the US or abroad:

- A 20% investment tax credit for CCT which begins operation between 2000 and 2012;
- A production tax credit for output from the qualifying CCT based on the design heat rate for the first ten years of operation;
- A risk pool established by the Federal government that would be available to the owners of qualifying CCT during its first 3 years of operation to offset costs for modifications resulting from the technology's failure to achieve its design performance, up to 5% of the cost of the project.

The proposal raises serious concerns:

- As currently crafted, it may increase carbon emissions.
 - If the plants are built domestically, the environmental benefits will depend upon which other plants are being replaced. The document acknowledges that new capacity installed in the near term in the US will most likely be gas fired. To the extent that qualifying coal plants displace gas or renewable energy plants that have lower carbon emissions per kilowatt-hour of electricity generated, carbon emissions would increase rather than decrease.
- The document does not provide specific suggestions on how the incentives would work for overseas investments in CCT plants. Depending upon how the incentives are structured, they may be ineffective or overly generous.
 - The proposed tax incentives may not be effective for investments overseas that are usually undertaken through controlled foreign subsidiaries of US parent corporations because foreign subsidiaries of US parent corporations generally do not pay US tax and would not be eligible for the proposed tax incentives.
 - Allowing the US parent company to claim the tax incentives against its US tax on foreign income may be ineffective because many US parent corporations do not pay US tax on the foreign income of their subsidiaries. (Domestic tax is deferred until the income is remitted to the US parent company, and can be offset by foreign taxes paid.) Allowing the tax credits to be claimed against the parent's domestic tax liability would be too generous and a major change in US tax policy, because the tax subsidy would be provided for income that may be exempt from US tax.
- The proposed tax credits are very large in relation either to expected operating costs or the value of output from the facilities receiving the subsidy.

- The production tax credit alone (0.55 to 1.3 cents per kilowatt-hour for plants placed in service before 2009) largely offsets or exceeds the expected plant operating costs of under 0.7 cents per kilowatt-hour. The production credit is about 20 to 40 percent of the projected price of power in most US areas (about 3 cents per kilowatt-hour at the generating plant).
- The 20 percent investment tax credit and risk pooling add a further level of subsidy that is difficult to justify.
- The proposed subsidies are disproportionate to the potential environmental benefits of CCT technology.
 - When both operating and capital subsidies are considered, the proposed subsidies are comparable to those being provided to renewable technologies that have no greenhouse gas emissions. Since the proposed CCT plants would have emissions significantly higher than those of a combined-cycle gas-fired plant that are available today, the proposed subsidies are difficult to justify.

September 18, 1998

DISCUSSION:

This proposal is intended to provide a technology- and fuel-neutral incentive to modernize the nation's fleet of electricity generators. Due to the legacy of monopoly regulation, electricity generating units are among the oldest capital stock of any industrial sector in the United States, with about half of the generating capacity being more than 30 years old. This older capacity tends to be less efficient and much more heavily polluting than modern generating units. The performance-based investment tax credit proposed here would reduce the up front capital costs needed to replace this aging equipment with modern technology.

The minimum performance improvements specified above can be achieved with either coal or gas technology. Consider replacing an older, less efficient unit with a heat rate of 11,000 Btu/kWh. The 25% and 50% improvement requirements would mean that the replacement units would have to achieve a heat rate of 8,250 Btu/kWh for the 10% credit, and 5,500 Btu/kWh for the 20% credit. DOE's performance goals for both advanced pressurized fluidized bed (PFBC) and integrated gasification combined cycle (IGCC) technology is a generation efficiency of at least 50%, or a heat rate of less than 6,825 Btu/kWh, substantially better than needed to qualify for the 10% credit. DOE's performance goal for its Vision 21 plant (which is an advanced IGCC plant using an oxygen-blown gasifier) is 65% efficiency, or a heat rate of 5,250, low enough to qualify for the 20% credit. Use of combined heat and power technology would make either of these performance goals substantially easier to meet.

The requirement that the units being replaced had to operate with a 50% capacity factor during the previous 5 year period is intended to ensure that the tax credit gets the greatest possible bang-for-the-buck by excluding simple-cycle combustion turbine peaking units (which are likely to be replaced by combined cycle units in any case) and units that have effectively been removed from service without being formally retired.

The treatment of combined heat and power (CHP or cogeneration) plants is intended to provide a level playing field for this high efficiency technology. If it were not for the use of this technology, fuel would have to be consumed in separate boilers to produce steam for use in, for example, an industrial process or district heating system. The CHP plant receives credit for this avoided fuel consumption, based on the assumption that the separate boiler would have an efficiency of approximately 80% (hence the factor of 1.2).

TITLE V. FOSSIL FUEL EFFICIENCY IMPROVEMENTS

10% investment tax credit for repowering or replacing existing fossil fuel generating units with technology that results in at least a 25% reduction in fossil fuel heat input per kilowatt-hour of net electricity generation.

20% investment tax credit for repowering or replacing existing fossil fuel generating units with technology that results in at least a 50% reduction in fossil fuel heat input per kilowatt-hour of net electricity generation.

Eligible units. To qualify for the credit, the unit(s) being repowered or replaced must have operated with an average capacity factor of at least 50% during the five year period prior to enactment. The investment tax credit can only be taken on that portion of the investment attributable to providing generating capacity not greater than the generating capacity of the unit(s) being repowered or replaced. Repowering means permanent modification of the generating unit so as to reduce the design average net heat rate by at least 25%. Replacement means permanent retirement of the existing generating unit and replacement of that amount of generating capacity with a new unit that has a design average net heat rate at least 25% lower than the retired unit.

Treatment of combined heat and power plants (CHP or cogeneration). In the case of plants that produce both steam and electricity for sale, the net heat rate of electricity generation shall be calculated by subtracting 1.2 times the Btu content of the steam sold from the total Btus of heat input to the combined heat and power plant.



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TAX POLICY

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- The proposed subsidies are disproportionate to the potential environmental benefits of CCT technology.
 - When both operating and capital subsidies are considered, the proposed subsidies are comparable to those being provided to renewable technologies that have no greenhouse gas emissions. Since the proposed CCT plants would have emissions significantly higher than those of a combined-cycle gas-fired plant that are available today, the proposed subsidies are difficult to justify.

September 18, 1998

From: Dirk Forrister on 01/21/99 09:25:00 AM

Record Type: Record

To: Julie M. Anderson/WHCCTF/EOP

cc:

Subject:

----- Forwarded by Dirk Forrister/WHCCTF/EOP on 01/21/99 09:26 AM -----

From: Dirk Forrister on 01/20/99 05:32:21 PM

Record Type: Record

To: Todd Stern/WHO/EOP, Roger S. Ballentine/WHO/EOP, David B Sandalow/CEQ/EOP

cc:

Subject:



COALMTG.MEM

Please find a short background paper for the meeting with Senator Byrd's staff tomorrow. This updated version incorporates the topics we covered in the 1:00 prep session. Here's a short-short version of our key messages to use as you prepare your own cheat-sheet.

Economic Analysis: While we recognize that the nation's climate response will have some effects on coal, our analysis shows that an economically efficient policy framework will minimize those impacts. Coal will continue to play an important role in America's energy mix for many years to come.

Technology Initiatives: Our portfolio of climate programs includes continued work on advanced coal R&D, sequestration and efficiency in mining. Our tax incentives will be changing modestly -- but still hold some potential for coal-based strategies to play a role through combined heat and power as well as improved biomass cofiring provisions.

Credit for Early Action: The President expressed interest in the State of the Union. We're committed to work with you to get a bill done.

Surface Mining: We see a valuable role emerging for our mined land reclamation programs -- they are focusing more on ways of including reforestation strategies to play a larger role. While not by any means the total solution, his program has the advantage of putting dollars and jobs into coal mining communities.

New Issues: We Know We Can Do Even Better: We know your interest in the tax incentive proposal by the Coal Utilization Research Council -- and we are continuing to examine it. We are also working with the steel and coke industries on their interest in tax incentives for advanced coking technologies. We have concerns with both proposals -- and we have funding constraints that kept us from adding new initiatives on the tax side. That said, we will continue to work with them should the funding prospects

change later in the year.

International: We know y our interest in China, and we are developing some alternatives to prompt more clean coal technology partnerships there. We are also hearing soundings from Sen. Hagel that he may be planning a legislative effort this year -- and we hope that we can work closely with you if anything materializes on that front.

Clean Coal Technology

Incentives and R&D Program
for Early Commercial Applications of
Clean Coal Technology

Winter 1999

COAL UTILIZATION RESEARCH COUNCIL

Clean Coal Technologies

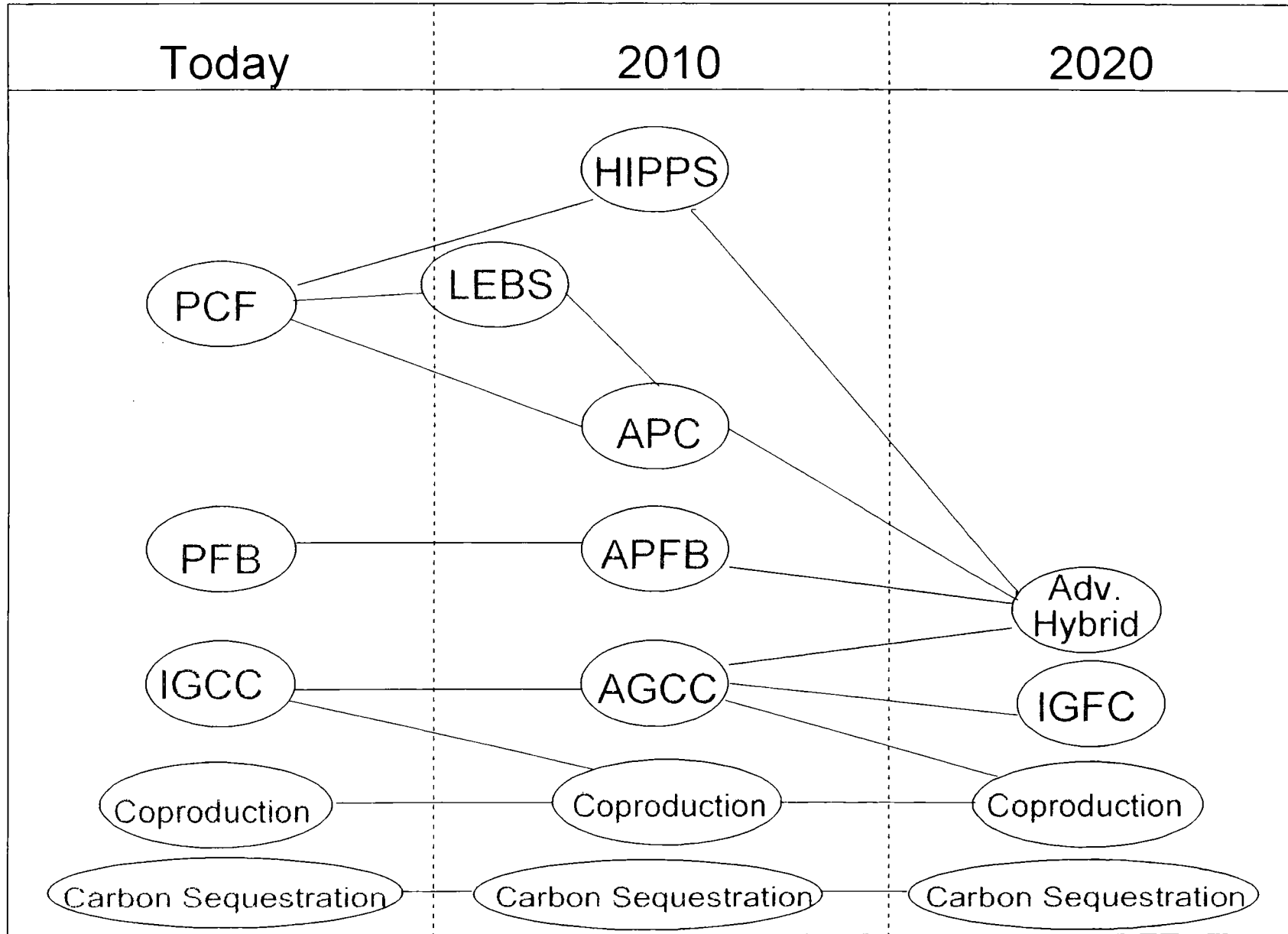
Technology Promise

- Climate Change Initiative Proposed by the Administration
 - Immediate actions to stimulate the use of technologies that minimize costs to reduce greenhouse gas emissions
 - R&D and tax incentives aimed at deployment of energy efficient, carbon-reduction technologies
 - Electricity generating sector research program for innovative coal combustion approaches that offer the possibility of much lower carbon emissions
- ***Clean Coal Technologies (CCTs) can be further developed and deployed to cause or induce real increases in efficiency and decreases in carbon emissions from domestic and international electricity generation***

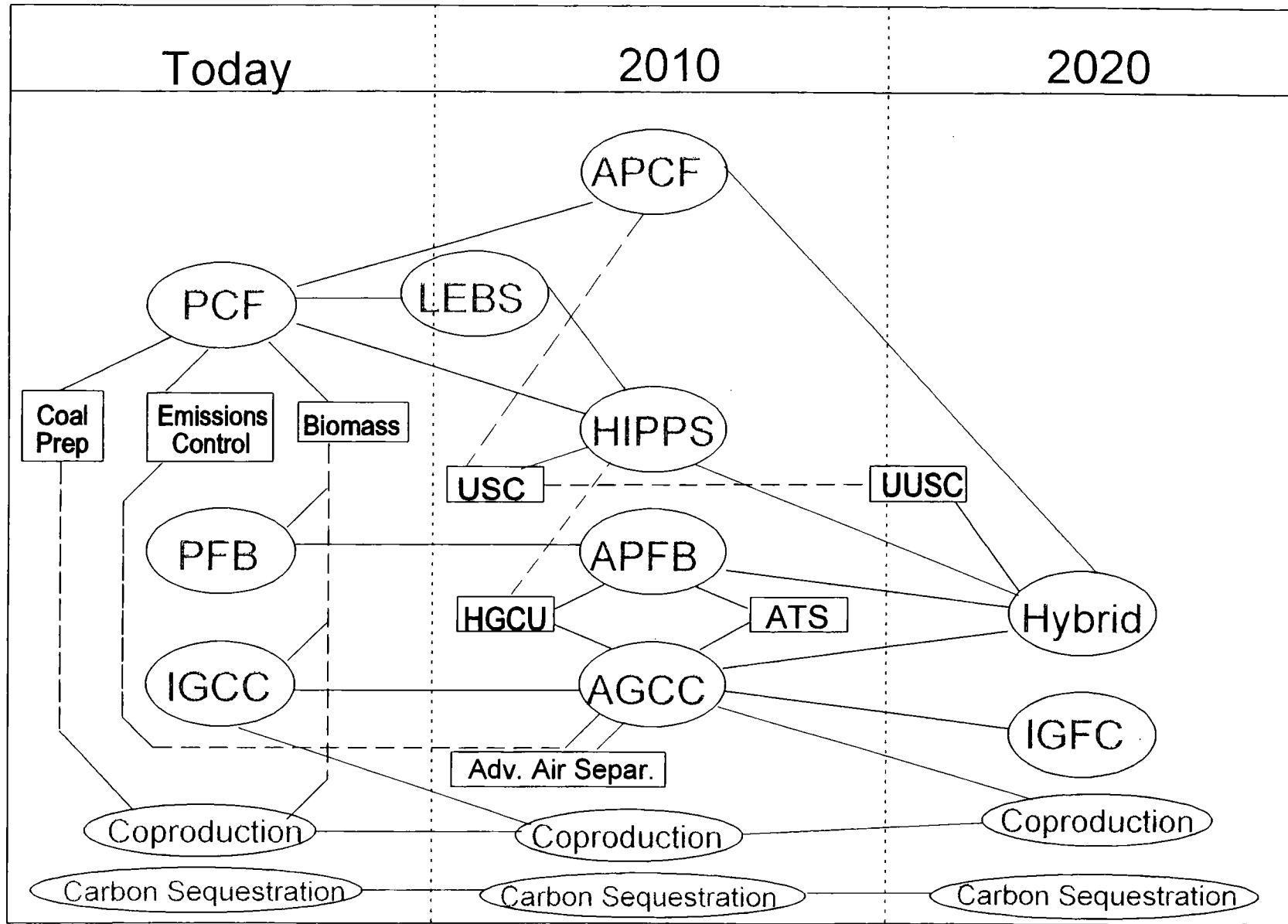
Performance Targets for Coal Generation

Performance Target	Today	2010	2020
Capital Cost, \$/kW	900 -1300	800	800
Efficiency, %HHV	40	45	50 - 60
SO₂, removal %	95	97	99
No_x lbs/mmbtu	0.1 - 0.3	0.08	0.05
HAPs (<i>hazardous air pollutants</i>)	define goals	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100

Coal Fired Power Plant Technologies

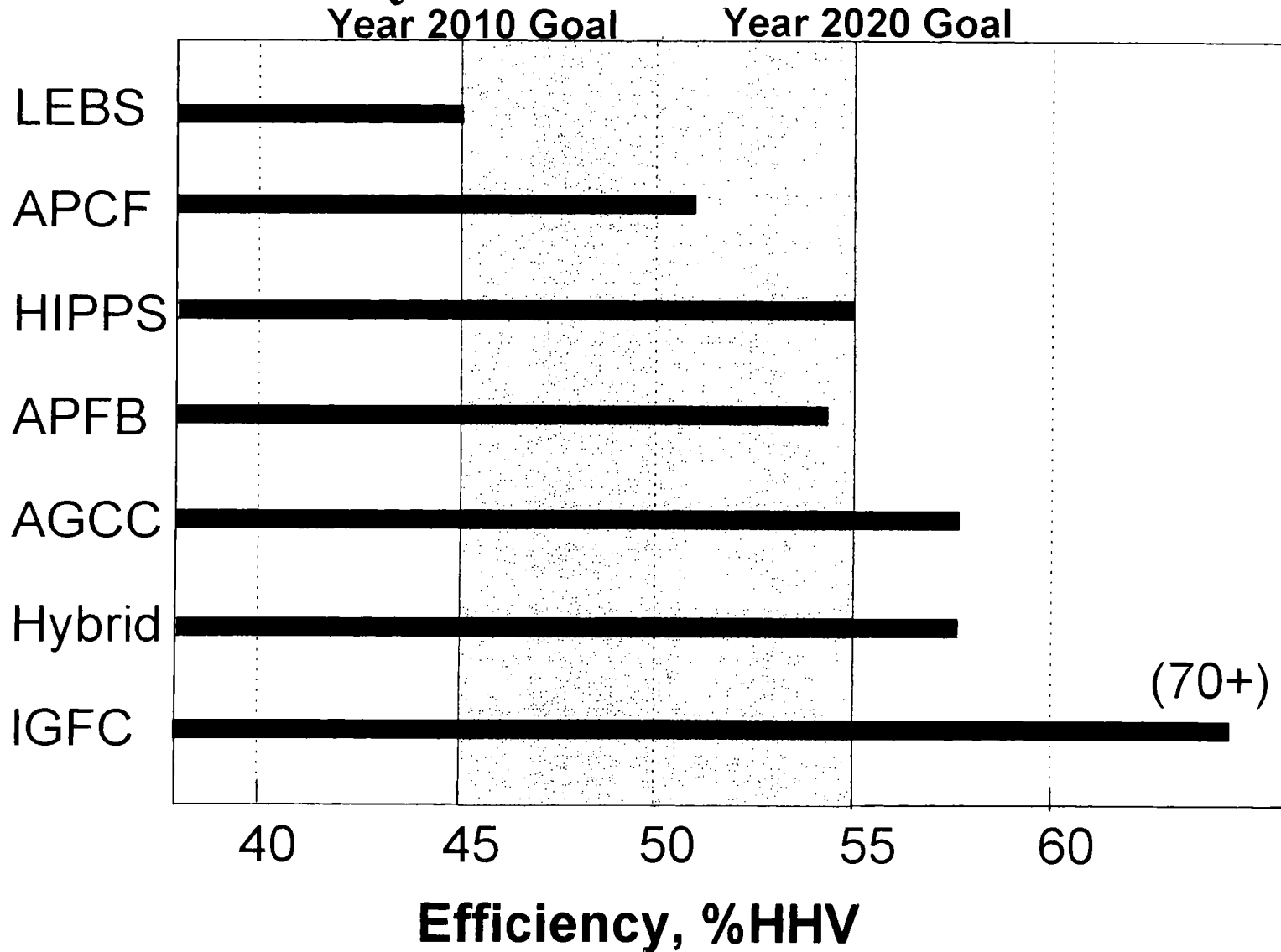


Coal Fired Power Plants / Enabling Technologies

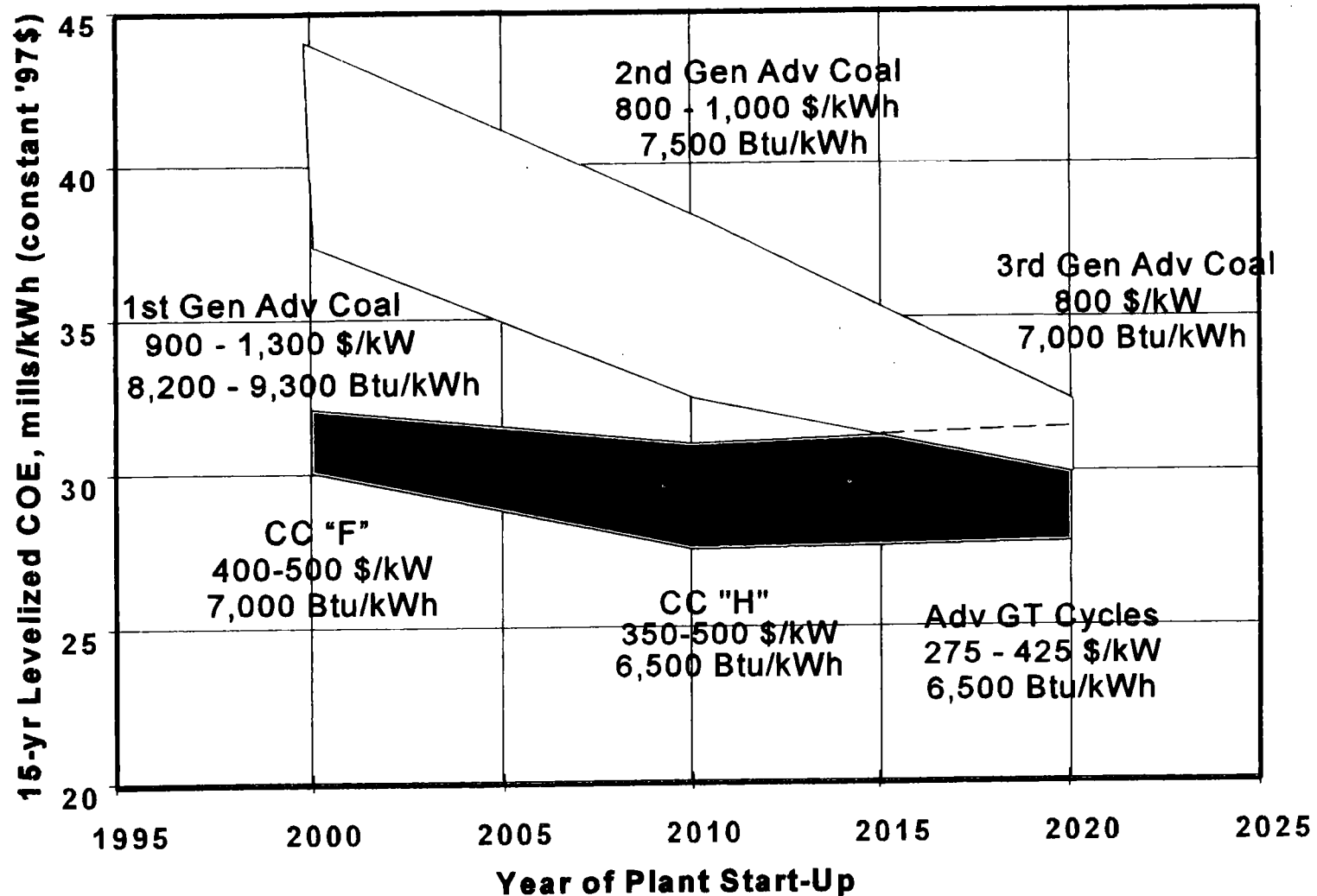


Enabling technologies to build industry core competencies include materials and lifing; sensors and controls; computational fluid dynamics; coal characterization; and coal preparation.

Efficiency Goals for Coal Fired Plants



15-Year Levelized Cost of Electricity for Coal Fired v. Gas Fired Power Technologies



Clean Coal Technologies

Environmental Impacts

- Environmental benefits:
 - 10 million metric ton reduction in domestic carbon emissions from the incentives
 - 294 million metric ton reduction in international carbon emissions from deployment of CCTs worldwide
 - 25% of the reduction required under a Kyoto type agreement

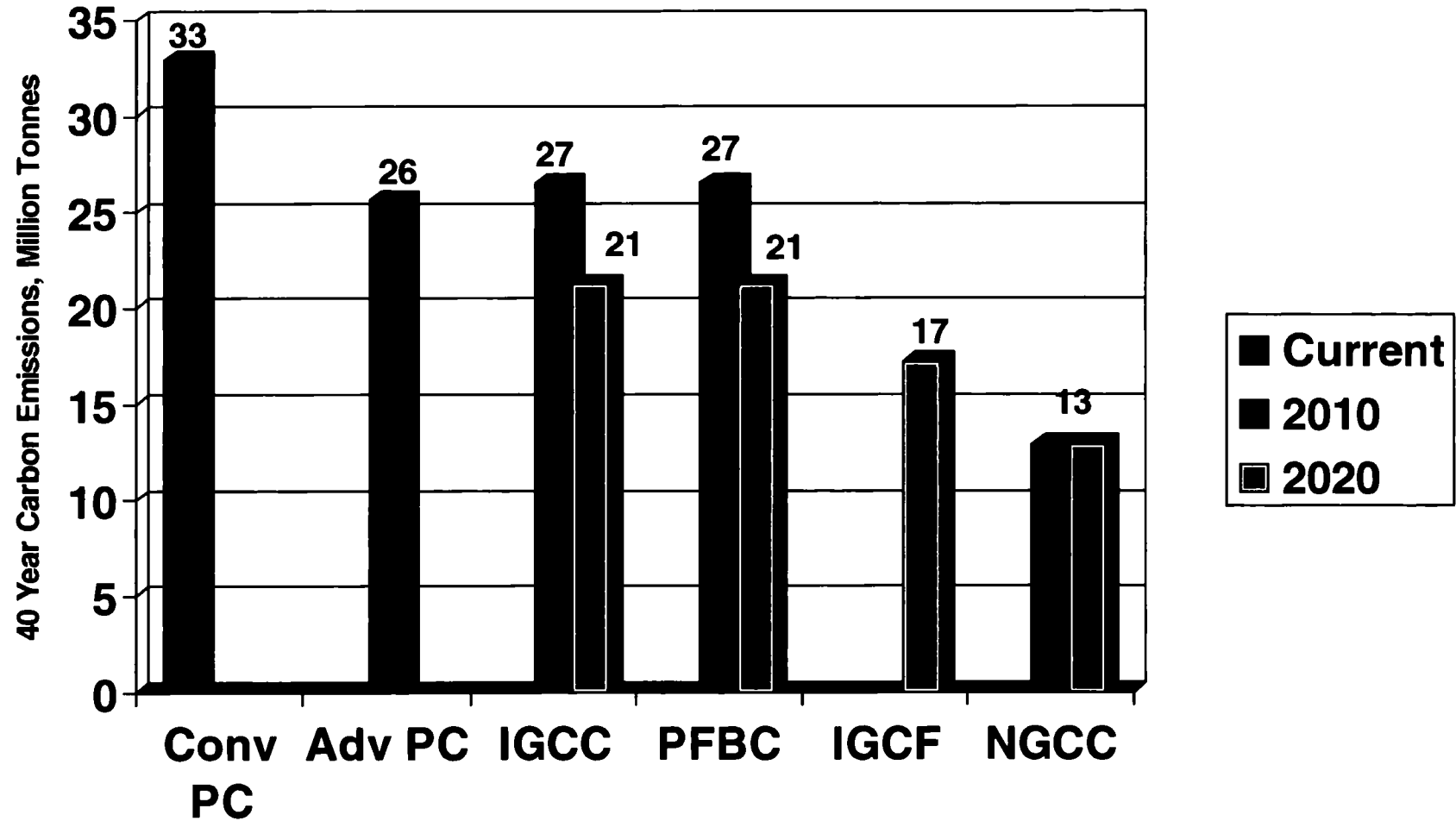
Clean Coal Technologies

Incentive and R&D Program Objectives

- **Fuel Diversity**
 - coal largest source of electricity generation
 - U.S. - 57%
 - World - 38%
 - coal is projected to remain the largest source of electricity
 - EIA AEO98 - 51% in 2020 even with a 400% increase in natural gas
 - OECD/IEA - 43% of the world's electricity in 2020
- **Technology Promise**
 - further R&D and deployment of early commercial applications will result in increased generating efficiency and lower carbon emissions
- **Sustainable Economy**
 - coal must remain a viable, readily available, competitive source of fuel for electricity generation, transportation fuels and chemical feed stocks to promote economic growth, price stability and energy security

Clean Coal Technologies

Carbon Emission Reduction Potential



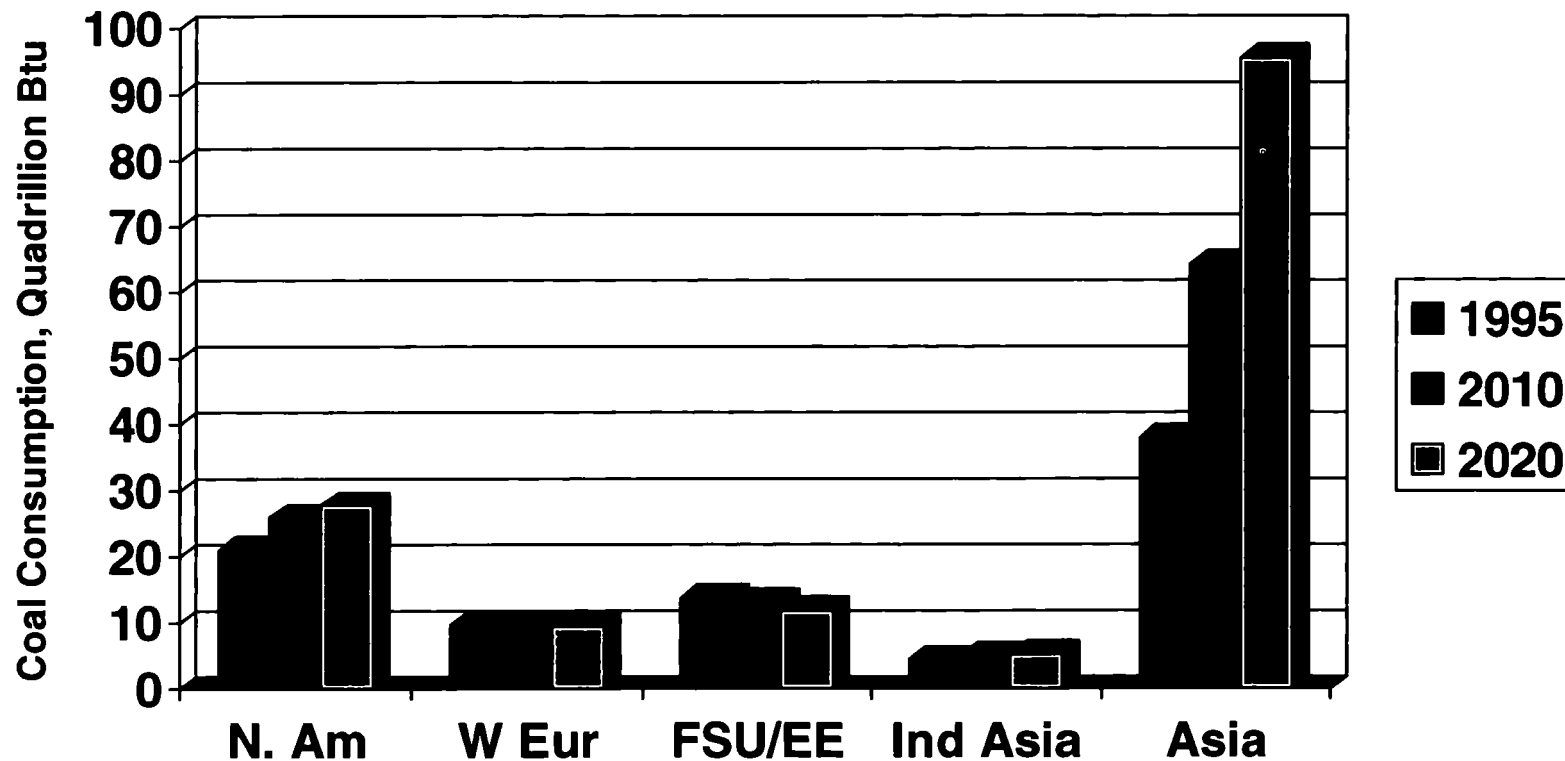
Clean Coal Technologies

Background

- CCT program will be successfully completed with demonstrated “first-of-a-kind” technologies to increase efficiency and reduce pollutants
- full commercial penetration requires 2-3 early commercial applications of these promising technologies
- developers unable to accept technical and financial risk of a “not yet fully commercial” application
 - lack of need for new base load capacity
 - utility deregulation - become more risk adverse
 - competition from natural gas
- Developing countries require large amounts of new capacity - much of it coal fired, but CCTs will not be utilized

Clean Coal Technologies

Projected World Coal Consumption



Source: EIA International Energy Outlook, 1998, April 1998

Clean Coal Technologies

Key Issues

- Coal will continue to be used domestically and internationally
- Carbon emissions will continue to rise
- Conventional coal combustion is 37% efficient
- CCTs offer the promise of efficiencies exceeding 50%
- Full commercial deployment of CCTs can cause or induce real reductions in carbon emissions
- ***Full commercial deployment of CCTs will require incentives for a limited number of early commercial applications***
- ***Achievement of the CCTs full efficiency gain and emission reduction potential will require a continued R&D effort to support the early commercial applications***

Clean Coal Technologies

Benefits of Incentives for Early Commercial Applications

- Accelerate commercial availability of CCTs as an option for achieving economic and environmental goals
- Cause or induce real carbon emission reductions domestically and internationally
- Keep US CCTs in forefront and globally competitive
- Create jobs and favorable economic contributions to the U.S. economy

Clean Coal Technologies

Criteria for Incentives

- Tax incentives preferred over direct subsidies
- Address technical and economic risks of early commercial applications of CCTs
- Program should focus on coal fired CCTs, but be robust enough to address co-firing with renewables
- Apply only to those technologies that measurably increase thermal efficiency and reduce carbon emissions
- Target both domestic and international early commercial applications
- Address the higher capital and operating costs and the increased potential, inherent with new technology, for modifications to achieve design specifications

Clean Coal Technologies

Proposed Incentives

- Investment tax credit
 - 20% of the project owner or parent company equity investment
- Production tax credit
 - variable incentive based on the production rate and efficiency of the technology over the first 10 years of operation

Operation beginning during or before	Design Average Heat Rate Btu/kWh (HHV)	Incentive for First 5 years of Operation, cents/kWh Generated	Incentive for Second 5 years of Operation, cents/kWh Generated
2004	8400 or less	1.30	1.10
	8401-8550	1.00	0.85
	8551-8750	0.90	0.70
2008	7770 or less	1.00	0.80
	7771-8125	0.80	0.65
	8126-8350	0.70	0.55
2012	7720 or less	0.85	0.70
	7721-7380	0.70	0.45

Clean Coal Technologies

Proposed Incentives (Continued)

- Risk pool
 - 5% of the installed cost available from the Federal Gov't to cover repairs or modifications required to achieve design performance level during start-up and the initial 3 year operating period
- Qualification and selection criteria
 - limited capacity - 6000MW
 - limited period for installation - 2004 to 2012
 - every increasing efficiency threshold to qualify (39% to 46%), higher in later years
 - selection based on maximum efficiency and lowest cost to government

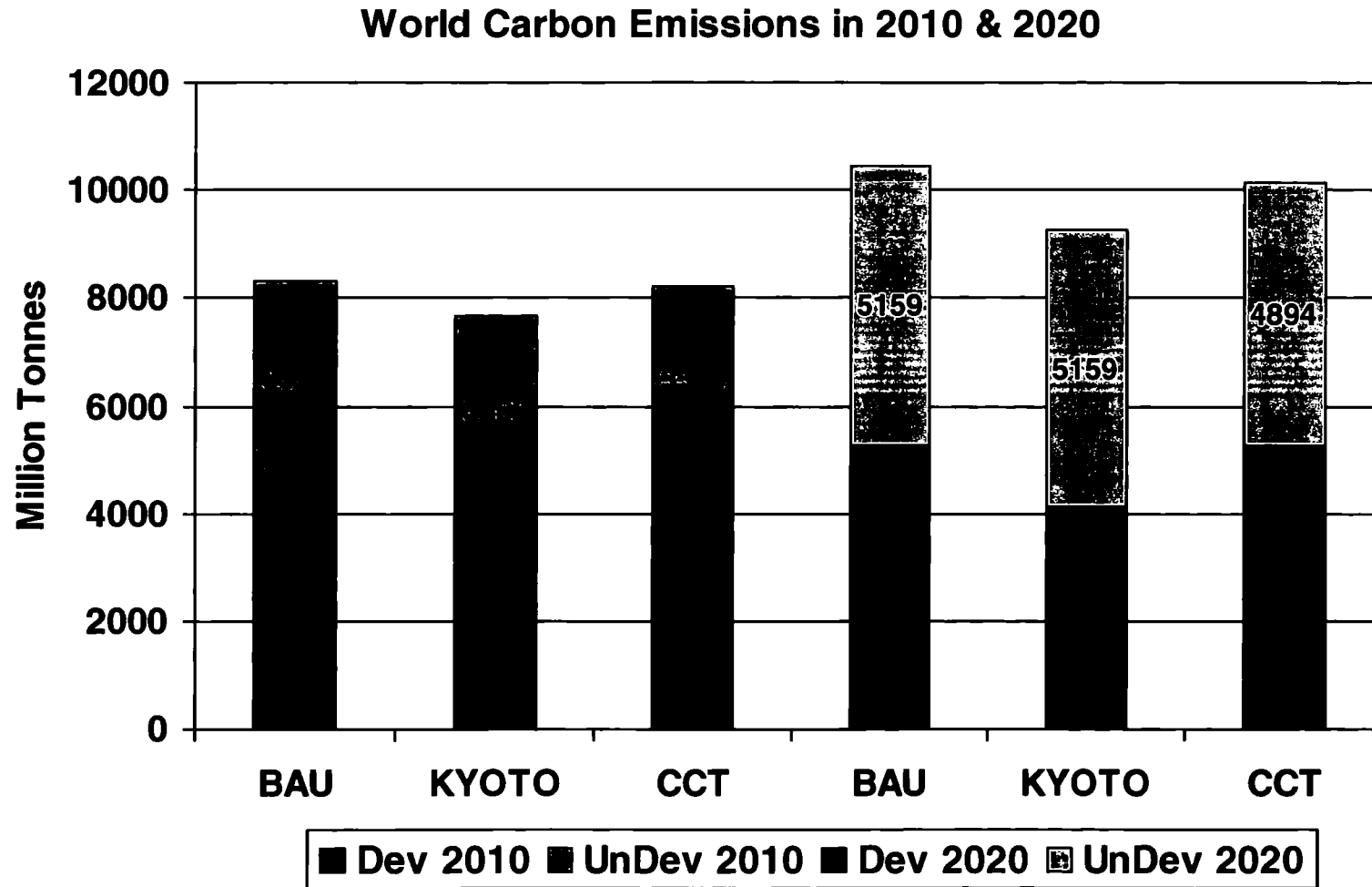
Clean Coal Technologies

Environmental Impacts

- Environmental benefits:
 - 10 million metric ton reduction in domestic carbon emissions from the incentives
 - 294 million metric ton reduction in international carbon emissions from deployment of CCTs worldwide
 - 25% of the reduction required under a Kyoto type agreement

Clean Coal Technologies

Environmental Impacts



Clean Coal Technologies

Revenue Impacts

- Revenue impacts over 23 year period (1999 -2021)

Incentive	1999-2003	2004-2008	2009-2013	1999-2021
		(Million 1998 \$ NPV)		
Investment Tax Credit	\$90	\$73	\$41	\$203
Production Tax Credit	\$0	\$377	\$439	\$1,023
Risk Pool	\$0	\$135	\$117	\$276
Total	\$90	\$585	\$597	\$1,502

Clean Coal Technology

Incentives and R&D Program
for Early Commercial Applications of
Clean Coal Technology

Winter 1999

COAL UTILIZATION RESEARCH COUNCIL

Clean Coal Technologies

Technology Promise

- Climate Change Technology Initiative proposed in Administration's FY 2000 budget
 - designed to promote energy efficiency, develop low carbon energy sources and reduce greenhouse gas emissions
 - \$1.4 billion R&D spending on energy efficiency and renewable energy technologies
 - \$0.4 billion for tax credits to stimulate adoption of energy efficient technologies in building, industrial processes, vehicles, and power generation
- FY 2000 budget proposes \$321 million in bilateral and multilateral environmental assistance to address climate change issues in developing countries
- ***Clean Coal Technologies (CCTs) can be further developed and deployed to cause or induce real increases in efficiency and decreases in carbon emissions from domestic and international electricity generation***

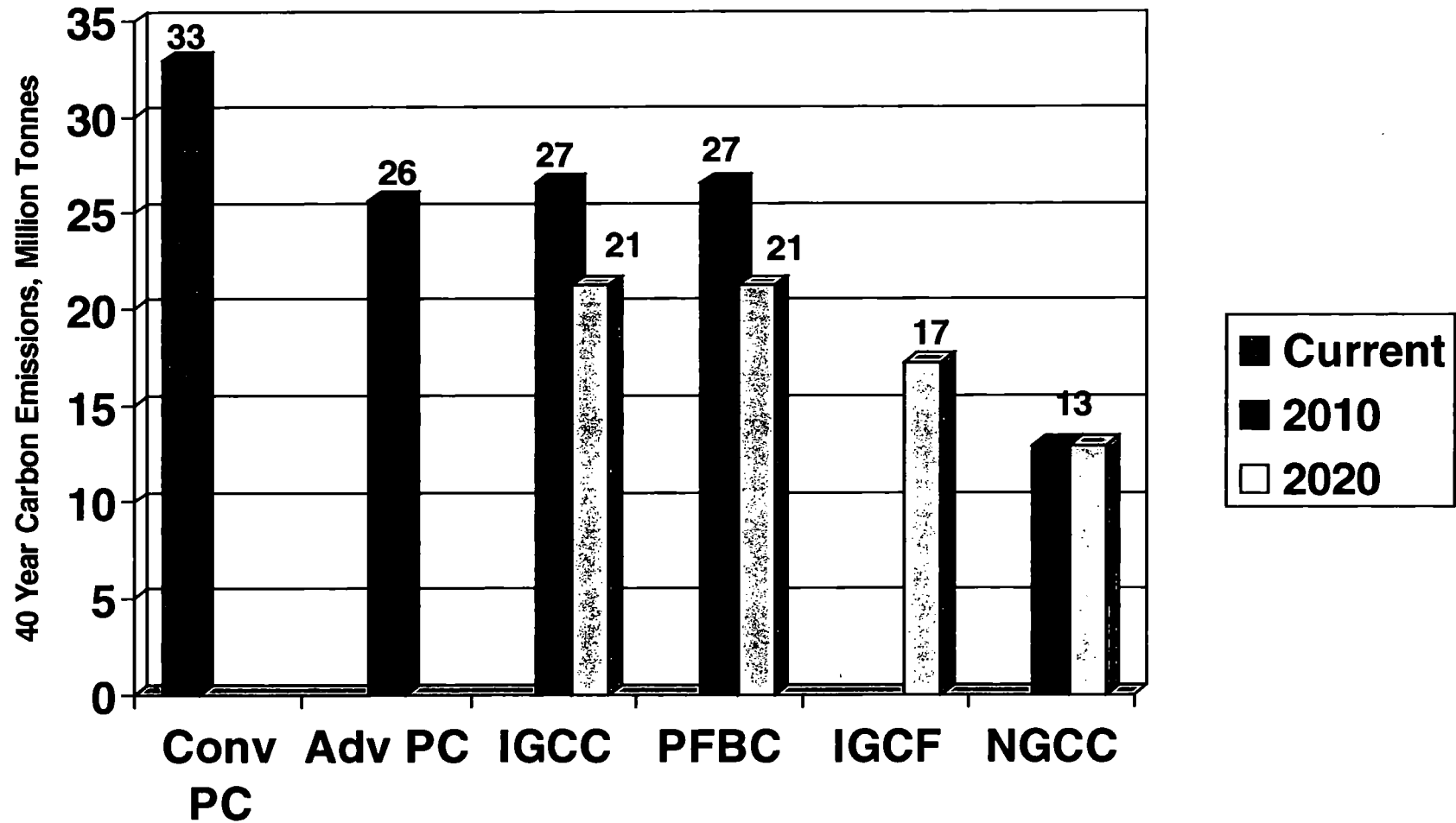
Clean Coal Technologies

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 - coal largest source of electricity generation
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 - coal is projected to remain the largest source of electricity
 - EIA AEO98 - 51% in 2020 even with a 400% increase in natural gas
 - OECD/IEA - 43% of the world's electricity in 2020
- **Technology Promise**
 - further R&D and deployment of early commercial applications will result in increased generating efficiency and lower carbon emissions
- **Sustainable Economy**
 - coal must remain a viable, readily available, competitive source of fuel for electricity generation, transportation fuels and chemical feed stocks to promote economic growth, price stability and energy security

Clean Coal Technologies

Carbon Emission Reduction Potential



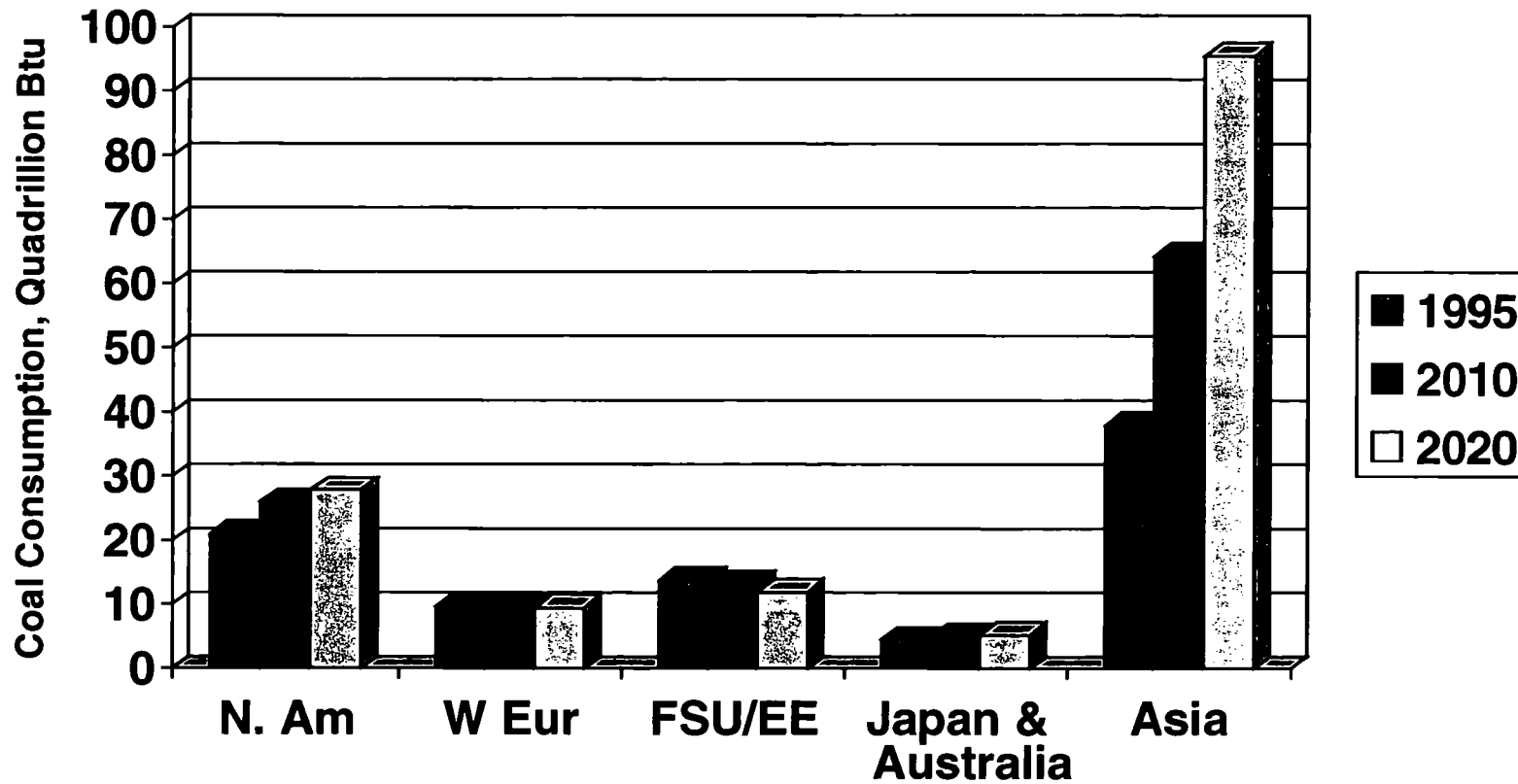
Clean Coal Technologies

Background

- CCT program will be successfully completed with demonstrated “first-of-a-kind” technologies to increase efficiency and reduce pollutants
- full commercial penetration requires 2-3 early commercial applications of these promising technologies
- developers unable to accept technical and financial risk of a “not yet fully commercial” application
 - lack of need for new base load capacity
 - utility deregulation - become more risk adverse
 - competition from natural gas
- Developing countries require large amounts of new capacity - much of it coal fired, but CCTs will not be utilized

Clean Coal Technologies

Projected World Coal Consumption



Source: EIA International Energy Outlook, 1998, April 1998

Clean Coal Technologies

Key Issues

- Coal will continue to be used domestically and internationally
- Carbon emissions will continue to rise
- Conventional coal combustion is 37% efficient
- CCTs offer the promise of efficiencies exceeding 50%
- Full commercial deployment of CCTs can cause or induce real reductions in carbon emissions
- ***Full commercial deployment of CCTs will require incentives for a limited number of early commercial applications***
- ***Achievement of the CCTs full efficiency gain and emission reduction potential will require a continued R&D effort to support the early commercial applications***

Clean Coal Technologies

Criteria for Incentives

- Tax incentives preferred over direct subsidies
- Address technical and economic risks of early commercial applications of CCTs
- Program should focus on coal fired CCTs, but be robust enough to address co-firing with renewables
- Apply only to those technologies that measurably increase thermal efficiency and reduce carbon emissions
- Place priority on early commercial applications in the US, but allow for international applications, if domestic opportunities fail to materialize
- Address the higher capital and operating costs and the increased potential, inherent with new technology, for modifications to achieve design specifications

Clean Coal Technologies

Proposed Incentives

- Investment tax credit
 - 10% of the project owner or parent company investment
- Production tax credit
 - variable incentive based on the production rate and efficiency of the technology over the first 10 years of operation

Operation beginning during or before	Design Average Heat Rate Btu/kWh (HHV)	Incentive for First 5 years of Operation, cents/kWh Generated	Incentive for Second 5 years of Operation, cents/kWh Generated
2004	8400 or less	1.30	1.15
	8401-8550	1.00	0.80
	8551-8750	0.75	0.60
2008	7770 or less	1.35	1.10
	7771-8125	1.15	0.90
	8126-8350	0.90	0.80
2012	7380 or less	1.55	1.35
	7381-7720	1.35	1.15

Clean Coal Technologies

Proposed Incentives (Continued)

- Risk pool
 - 5% of the installed cost available from the Federal Gov't to cover repairs or modifications required to achieve design performance level during start-up and the initial 3 year operating period
- Qualification and selection criteria
 - limited capacity - 6000MW *2000 MW undefined could be biomass*
 - limited period for installation - 2004 to 2012
 - every increasing efficiency threshold to qualify (39% to 46%), higher in later years
 - selection based on maximum efficiency and lowest cost to government

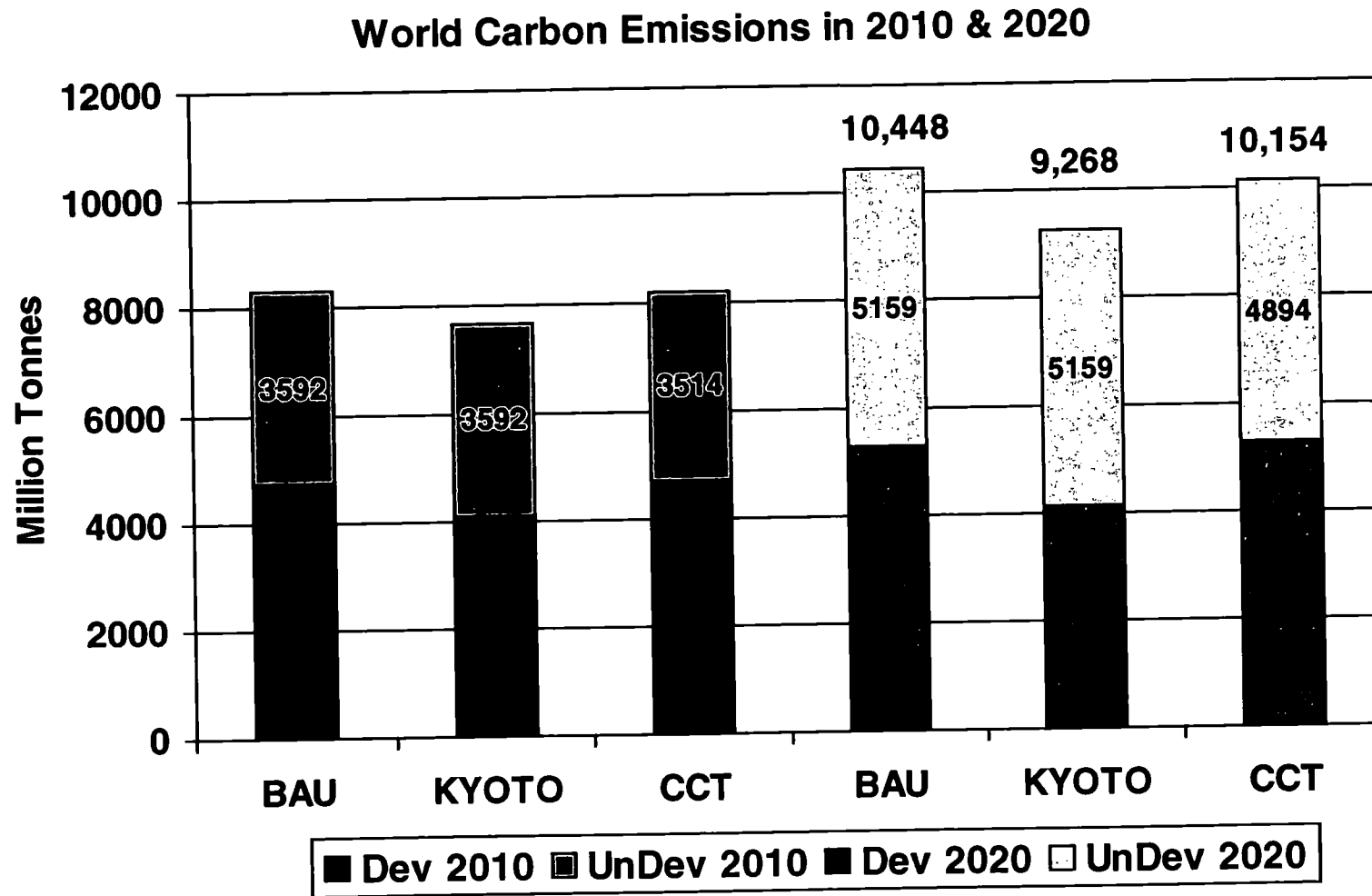
Clean Coal Technologies

Environmental Impacts

- Example of worldwide commercial applications:
 - 10% of coal combustion by 2010
 - 50% of new coal combustion between 2010 and 2015
 - 75% of new coal combustion between 2015 and 2020
- Potential environmental benefits:
 - 10 million metric ton reduction in domestic carbon emissions from the incentives program
 - 294 million metric ton reduction in worldwide carbon emissions per year by 2020 from deployment of CCTs worldwide
 - 25% of the developed country reduction required under a Kyoto type agreement

Clean Coal Technologies

Environmental Impacts



Clean Coal Technologies

Revenue Impacts

- Revenue impacts over 22 year period (2000 -2021)

Incentive	2000- 2004	2005- 2009	2010- 2014	2000- 2021
	(Million 1998 \$ NPV)			
Investment Tax Credit	\$180	\$145	\$81	\$406
Production Tax Credit	\$59	\$383	\$485	\$1,214
Risk Pool	\$34	\$136	\$107	\$276
Total	\$273	\$664	\$673	\$1,896

INCENTIVES FOR THE EARLY COMMERCIAL APPLICATIONS OF CLEAN COAL TECHNOLOGY

The Challenge - Ensure that the U.S. energy supply is based on a diverse mix of fuels, incorporates the benefits promised by new technology, guarantees a sustainable economy, and meets all environmental goals.

The Solution - Clean Coal Technology (CCT) is critical to the U.S. effort to meet this challenge.

FUEL DIVERSITY CCT can avoid a dependence on a limited number of fuel sources for U.S. power production and will assure the reduction of carbon emissions without economic penalty.

TECHNOLOGY PROMISE CCT can dramatically increase efficiency and significantly reduce emissions from coal combustion.

SUSTAINABLE ECONOMY CCT can preserve and promote economic growth, energy price stability and national energy security by allowing coal to remain a readily available and competitive source of clean fuel for electric generation, transportation fuels and chemical feed stocks.

Today, a number of emerging clean coal technologies (CCTs) stand ready to be further developed and deployed to bring about real increases in the conversion efficiency of coal to electricity and real decreases in carbon emissions from power generation domestically and internationally. However, full commercial penetration for these technologies first requires building and operating experience from several early commercial applications for each major technology category. It is in the best interests of the United States to drive development of these early commercial applications as soon as possible, both at home and overseas. This will:

- accelerate the availability of commercially mature CCTs to enable the United States to meet future economic and environmental goals;
- result in real reductions of greenhouse gases wherever these early commercial applications occur;
- keep U.S. industry in the forefront of the world market place for CCTs; and
- create jobs and favorable economic contributions to the U.S. economy.

The Action Required - Development of these early commercial CCT applications will require a new program of limited financial incentives and continued R&D funding to overcome the associated technological and economic risks. The proposed program would be limited in scope (6000MW) and timing (installations placed in service between 2004 and 2012) and the technologies would be required to meet ever-increasing performance levels to qualify. U.S. tax code should be amended to provide for the following incentives:

- (1) an ***Investment Tax Credit*** equal to 20% of the project owner's equity investment,
- (2) a ***Production Tax Credit*** for each kilowatt hour generated over the first 10 years of operation and based on the technologies design net heat rate, and
- (3) a ***Risk Pool*** to offset costs, if any, for modifications resulting from the technology's failure to achieve its design performance during start-up and initial operation, limited to 5% of the total installed cost of the project.

Revision 4
11/16/98

**Incentives
and
Research & Development
for
Early Commercial Applications of
Clean Coal Technology**

November 1998

**Incentives
and
Research & Development
for
Early Commercial Applications of
Clean Coal Technology**

November 1998

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PROPOSAL

Divider Title: _____

**INCENTIVES FOR
 EARLY COMMERCIAL APPLICATIONS OF
 CLEAN COAL TECHNOLOGIES**

(1) Investment Tax Credit

The U.S. owner(s) or U.S. parent company(s) of the owner(s) of a Qualifying Clean Coal Technology, which is installed in the U.S. or abroad between 2000 and 2012, shall be entitled to a tax credit equal to 20% of the project owner's equity investment.

(2) Production Tax Credit

The U.S. owner(s) or U.S. parent company(s) of the owner(s) of a Qualifying Clean Coal Technology, which is installed in the U.S. or abroad and begins operation between 2000 and 2012, shall receive a production tax credit for each kilowatt hour generated over the first 10 years of operation and based on the technologies design net heat rate as indicated in the table below:

Operation beginning during or before	Design Average Net Heat Rate, Btu/kWh (HHV)*	Incentive for First 5 years of Operation, cents/kWh Generated	Incentive for Second 5 Years of Operation, cents/kWh Generated
2004	8400 or less	1.30	1.10
	8401-8550	1.00	0.85
	8551-8750	0.90	0.70
2008	7770 or less	1.00	0.80
	7771-8125	0.80	0.65
	8126-8350	0.70	0.55
2012	7720 or less	0.85	0.70
	7721-7380	0.70	0.45

*Note: Increased efficiency is equivalent to a lower net heat rate.

(3) Risk Pool

The federal government shall establish a financial Risk Pool that would be available to the U.S. owner(s) of a Qualifying Clean Coal Technology, installed in the U.S. or abroad, during its first 3 years of operation to offset costs, if any, for modifications resulting from the technology's failure to achieve its design performance during start-up and initial operation. The total amount of recoverable costs shall be limited to 5% of the total installed cost of the project.

(4) Definitions:

(a) **Conventional Technology** - (i) coal-fired combustion technology with a design average net heat rate of not less than 9,300 Btu/kWh (HHV) and a carbon equivalents emission rate of not more than 0.53 pounds of carbon per kilowatt hour; or (ii) natural gas-fired combustion technology with a design average net heat rate of not less than 7,500 Btu/kWh (HHV) and a carbon equivalents emission rate of not more than 0.24 lbs. of carbon per kilowatt hour.

(b) **Clean Coal Technology (CCT's)** - advanced technology that utilizes coal to produce 50% or more of its thermal output as electricity including advanced pulverized coal or atmospheric fluidized bed combustion, pressurized fluidized bed combustion, integrated gasification combined cycle, and any other advanced combustion technology that exceeds the performance of the conventional technology specified above.

(c) **Qualifying Clean Coal Technology** - (i) applications totaling 1,000 MW of advanced pulverized coal or atmospheric fluidized bed combustion technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2010 that have a design average net heat rate of not more than 8,750 Btu/kWh; (ii) applications totaling 1,500 MW of pressurized fluidized bed combustion technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2012 that have a design average net heat rate of not more than 8,400 Btu/kWh; (iii) applications totaling 1,500 MW of integrated gasification combined cycle technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2012 that have a design average net heat rate of not more than 8,550 Btu/kWh; and (iv) applications totaling 2000 MW or equivalent of technology for the production of electricity installed as a new, retrofit, or repowering application and operated between 2000 and 2012 that have a carbon emission rate that is no more than 85% of conventional technology. Clean coal technology projects receiving or scheduled to receive funding under the Department of Energy's Clean Coal Technology Program, shall not be eligible to be a Qualifying Clean Coal Technology as defined above.

(d) **Design Average Net Heat Rate** - shall be based on the design average annual heat input and the design average annual net electrical generating capacity of the Qualifying Clean Coal Technology at standard conditions. Co-generation of steam shall not be considered in determining a technology's Design Average Net Heat Rate.

(e) **Project Selection Criteria** - shall be established by the Department of Energy as part of a competitive solicitation for selecting Qualifying Clean Coal Technologies and the primary selection criteria shall be minimum design average net heat rate, maximum design average thermal efficiency and lowest cost to the government. DOE may establish other supplemental selection criteria as appropriate.

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INCENTIVES AND R & D

Divider Title: _____

Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology

In October of 1997, President Clinton proposed a three-stage approach for the U.S. to address climate change. The first stage consists of immediate actions to stimulate development and use of technologies that can minimize the cost of meeting U.S. goals for reducing greenhouse gas emissions. Among the actions were proposals for funding R&D as well as tax incentives aimed at deployment of energy efficient, renewable energy and carbon-reduction technologies. For the electricity-generating sector, the proposals called for DOE to initiate a research program on innovative new approaches to coal combustion that offer the possibility of much lower carbon emissions than existing technologies. While an increased emphasis on researching new technologies is needed, there are a number of emerging clean coal technologies (CCT's) that could be further developed and deployed to cause or induce real increases in the conversion efficiency of coal to electricity, which would in turn cause or induce real decreases in carbon emissions from power generation domestically and internationally through the use of U.S. technologies. The following discussion addresses the objectives, background and financial incentives for a program of incentives and research and development for the early commercial applications of Clean Coal Technologies.

Objectives of the Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology:

Fuel Diversity - Coal combustion is currently the largest source of energy for electricity production in the U.S. (55%) as well as the rest of the world (38%) and is projected to remain so for the foreseeable future. Development and deployment of highly efficient clean coal technologies will allow for the reduction of carbon emissions and avoid a dependence on a limited number of fuel sources for U.S. power production. According to the EIA's latest Annual Energy Outlook¹, coal is projected to generate 57% of the electricity consumed in 1998, and is to produce 52% and 51% respectively in 2010 and 2020. Coal remains the major U.S. source of electricity, even after over a 400% increase in electricity produced from natural gas between 1998 and 2020. The International Energy Agency of the OECD has projected that coal will provide 43% of the world's electricity in 2020². Development and deployment of these technologies globally will allow for the double opportunities of exporting U.S. technologies and reducing carbon emissions from developing countries.

¹ Energy Information Administration, Annual Energy Outlook 1998, Washington DC, November 1997.

² International Energy Agency, World Energy Prospects To 2020, Paris, March 1998.

Technology Promise - The clean coal technology program has allowed for the demonstration of a number of first-of-a-kind technologies that can increase efficiency and reduce carbon emissions from coal combustion. With further R&D and deployment, these technologies can be optimized for increased efficiency and lower carbon emissions and their technical and economic viability can be validated to ensure their commercial feasibility to enter the market place in the intermediate term (2010).

Sustainable Economy - Coal must remain a viable, readily available, and competitive source of fuel for electric power generation and become a significant source of transportation fuels and chemical feed stocks in order to preserve and promote economic growth, energy price stability and national energy security.

Background for the Clean Coal Technology Program

It is in the U.S. national interest to retain coal as a viable fuel source in order to preserve fuel flexibility and to assure energy security for the country. In the past, coal related R&D and technology demonstration efforts have shown that coal can be burned in a manner that is consistent with the country's economic and environmental goals. The current Clean Coal Technology Program has demonstrated a number of excellent options to increase efficiency and reduce emissions. However, full commercial penetration of these technologies will require building and operating experience from the next 2-3 early commercial applications for each major technology category, e.g. APCS, PFBC, IGCC, etc.

In order to install these early commercial applications, the designer, manufacturer, financier and owner must be willing to accept the technological and economic risk associated with the not yet fully commercial technology. With impending deregulation, electricity producers in the U.S. are not able to assume this risk in comparison to installing conventional technologies. After deregulation, 2005 and beyond, the developers of new electric generating plants will typically be more risk adverse.

Furthermore, the U.S. currently has ample generating capacity through 2005 and little if any base-load capacity will be constructed. New capacity, which may be installed, will most probably be natural gas-fired because of its lower equipment cost and projected lower cost of gas over the near term. In contrast to the U.S., developing countries will be installing large amounts of new generating capacity and much of it will be coal-fired.

Therefore it is in the best interests of the U.S. to promote the installation of these early commercial applications as soon as possible, including consideration of encouraging U.S. companies and U.S. clean coal technology to be installed overseas. This will:

- accelerate the availability of commercially mature CCT's so that the option is available to the U.S. to meet its future economic and environmental goals;
- result in real reductions of greenhouse gases wherever these early commercial applications occur;
- keep U.S. industry in the forefront of CCT development and competitive in the world market place; and
- create jobs and favorable economic contributions to the U.S. economy.

Promotion of the installation of these early commercial applications of the CCT's will require continued R&D funding and new financial incentives to overcome the associated technological and economic risks.

Criteria for Financial Incentives for the Early Commercial Applications of Clean Coal Technology:

- Tax Incentives are preferred over direct subsidies.
- Incentives are to address technical and commercial risk associated with the development and deployment of a new technology.
- Program should be robust enough to encompass all fuels, but have a primary emphasis on coal.
- Program should have a limited timeframe of 2000 to 2012 to address only the early commercial applications of new technologies.
- Incentives would apply only to those technologies that measurably increase thermal efficiency or reduce carbon emissions in comparison to conventional technologies.
- Incentives should first target domestic markets for deployment of the early commercial applications, but the incentives should be applicable to international applications of qualifying U.S. technologies by U.S. companies if domestic markets fail to offer sufficient opportunities for timely commercialization.

Proposed Financial Incentives for the Early Commercial Applications of Clean Coal Technology:

The following incentives represent the minimum set of financial mechanisms that will overcome the higher capital cost and greater operating risk associated with early commercial applications of CCT's. Exclusion of any one of the incentives will cause the CCT to become uneconomical or too great a risk for the owner to install the technology in comparison to conventional technology, which at the present time would most likely be natural gas combined cycle technology.

Proposed Incentives:

Section 1 - Incentives

(1) **Investment Tax Credit** - The U.S. owner(s) or U.S. parent company(s) of the owner(s) of a Qualifying Clean Coal Technology, which is installed in the U.S. or abroad between 2000 and 2012, shall be entitled to a tax credit equal to 20% of the project owner's equity investment.

(2) **Production Tax Credit** - The U.S. owner(s) or U.S. parent company(s) of the owner(s) of a Qualifying Clean Coal Technology, which is installed in the U.S. or abroad and begins operation between 2000 and 2012, shall receive a production tax credit for each kilowatt hour generated over the first 10 years of operation and based on the technologies design net heat rate as indicated in the table below:

Operation beginning during or before	Design Average Net Heat Rate, Btu/kWh (HHV)*	Incentive for First 5 years of Operation, cents/kWh Generated	Incentive for Second 5 Years of Operation, cents/kWh Generated
2004	8400 or less	1.30	1.10
	8401-8550	1.00	0.85
	8551-8750	0.90	0.70
2008	7770 or less	1.00	0.80
	7771-8125	0.80	0.65
	8126-8350	0.70	0.55
2012	7720 or less	0.85	0.70
	7721-7380	0.70	0.45

*Note: Increased efficiency is equivalent to a lower Net Heat Rate.

(3) **Risk Pool** - The federal government would establish a Risk Pool that would be available to the owner(s) of a Qualifying Clean Coal Technology, which is installed in the U.S. or abroad, during its first 3 years of operation to offset costs, if any, for modifications resulting from the technology's failure to achieve its design performance during start-up and initial operation. The total amount of recoverable costs shall be limited to 5% of the total installed cost of the project.

Section 2 - Definitions:

(a) **Conventional Technology** - (i) coal-fired combustion technology with a design average net heat rate of not less than 9,300 Btu/kWh (HHV) and a carbon equivalents emission rate of not more than 0.53 pounds of carbon per kilowatt hour; (ii) natural gas-fired combustion technology with a design average net heat rate of not less than 7,500 Btu/kWh (HHV) and a carbon equivalents emission rate of not more than 0.24 lbs. of carbon per kilowatt hour.

(b) **Clean Coal Technology (CCT's)** - advanced technology that utilizes coal to produce 50% or more of its thermal output as electricity, including advanced pulverized coal or atmospheric fluidized bed combustion, pressurized fluidized bed combustion, integrated gasification combined cycle, and any other advanced combustion technology that exceeds the performance of the conventional technology specified above.

(c) **Qualifying Clean Coal Technology** - (i) applications totaling 1,000 MW of advanced pulverized coal or atmospheric fluidized bed combustion technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2010 that have a design average net heat rate of not more than 8,750 Btu/kWh; (ii) applications totaling 1,500 MW of pressurized fluidized bed combustion technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2012 that have a design average net heat rate of not more than 8,400 Btu/kWh; (iii) applications totaling 1,500 MW of integrated gasification combined cycle technology installed as a new, retrofit, or repowering applications and operated between 2000 and 2012 that have a design average net heat rate of not more than 8,550 Btu/kWh; and (iv) applications totaling 2000 MW or equivalent of technology for the production of electricity installed as a new, retrofit, or repowering application and operated between 2000 and 2012 that have a carbon emission rate that is no more than 85% of conventional technology. Clean coal technology projects receiving or scheduled to receive funding under the Department of Energy's Clean Coal Technology Program, shall not be eligible to be a Qualifying Clean Coal Technology as defined above.

(d) **Design Average Net Heat Rate** - shall be based on the design average annual heat input and the design average annual net electrical generating capacity of the Qualifying Clean Coal Technology at standard conditions. Co-generation of steam shall not be considered in determining a technology's Design Average Net Heat Rate.

(e) **Project Selection Criteria** - shall be established by the Department of Energy as part of a competitive solicitation for selecting Qualifying Clean Coal Technologies and the primary selection criteria shall be minimum design average net heat rate, maximum design average thermal efficiency and lowest cost to the government. DOE may establish other supplemental selection criteria as appropriate.

Impact on U.S. Tax Revenue from the Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology:

The cost of the tax incentives and Risk Pool appropriations requirements over the first 10 years of the program would be \$675 million (1998\$). The total cost of the program over its 22 years life would be \$1,502 million.

The EIA³ has estimated that between 1998 and 2020, 24,000 MW of coal-fired and 169,930 MW of natural gas-fired electric generating capacity will be installed in the U.S. Encouraging the early commercial application of CCT's with a combined generating capacity of 6,000 MW to be part of this new capacity could be accomplished through a combination of investment tax credits and production tax credits offered over a limited number of years. It is anticipated that the 6,000 MW of CCT's will be installed in steps with each subsequent installation achieving improved operating and financial performance. It takes approximately 3 years to build a commercial CCT project; therefore, it is unlikely that any Qualifying CCT's would be placed into service before 2004. These CCT's would need to be operated several years to validate their performance and provide a basis for further improvement of a technology's operating and financial characteristics.

At the earliest, the next set of CCT's would be placed into service in 2008 with the third and final set of qualifying CCT's coming on line in 2012. The period during which a Qualifying CCT must be placed in service to receive the tax credits is 2000 to 2012. The investment tax credits would apply to the first 4 years of construction and the production tax credit would apply to the first 10 years of operation. The Risk Pool would apply to the first 3 years of operation of each Qualifying CCT. The total period during which Qualifying CCT's could be receiving tax credits would be from 2000 to 2021.

The estimated impact on tax revenues of the credits and the appropriations requirements of the Risk Pool are shown in the following table:

Financial Impact of Qualifying CCT's Tax Credits (million 1998 \$ NPV)				
	1999-2003	2004-2008	2009-2013	1999-2021
Investment Tax Credit	\$90	\$73	\$41	\$203
Production Tax Credit	\$0	\$377	\$439	\$1,023
Risk Pool Appropriation	\$0	\$135	\$117	\$276
Total	\$90	\$585	\$597	\$1,502

The risk pool exposure to the federal government would be \$276 million, which is 5% of the total installed cost of the CCT's. However, the actual exposure would be less

³ EIA, AEO1998

because not all installations would be expected to experience problems severe enough during start-up and initial operation to require the use of all 5% of their installed cost.

The proposal is not open-ended like many previous tax incentives for developing technologies. There is an upper limit on the amount of clean coal technology that could be constructed under these tax incentives. The limitation is included in paragraph (4) Definitions, in terms of megawatts of capacity. No more than 6,000 MW of CCT's could receive these tax incentives. The proposal includes scenarios, for analysis purposes, as to how many plants of different types might be constructed. However, the number may vary, but not the limitation of 6,000 MW of electricity generating capacity.

An explanation of the assumptions and financial projections for the tax revenue impacts is contained in attachment A.

Environmental Benefits of the Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology:

A common trait among all of the CCT's is an increase in the thermal efficiency of converting fuel to electricity. Conventional technology being installed around the world today is approximately 37% efficient. It is anticipated that by 2010, advanced pulverized coal-fired systems, externally-fired heat exchanger power systems, advanced gasification combined cycle and advanced pressurized fluidized bed combustion will be able to achieve efficiencies of 45% to 47%. In addition, by 2020, hybrids of these same technologies with further improvements, combined with fuel cell technology are expected to achieve efficiencies of up to 60%.

As a result of these efficiency increases, greenhouse gas emissions of carbon will decrease by an amount equal to the improvement in efficiency over conventional technology. Over its forty-year life a conventional 450MW pulverized coal-fired electric generating unit would emit 32 million metric tons of carbon. By contrast, an advanced integrated gasification combined cycle (IGCC) unit would emit 29 million tonnes if installed today and would improve to between 26 million tonnes and 21 million tonnes if the advanced versions were available and installed in 2010 and 2020 respectively. This represents a potential reduction in carbon emissions of 35%. The DOE has estimated that the energy savings from increasing efficiency in U.S. coal-fired power plants to 50% would be the equivalent of:

- replacing 1.8 Billion light bulbs with energy saving types; or
- weatherizing 490 million homes - more than 5 times the number of U.S. homes.

The attached graph and table present the estimates of life cycle emissions of greenhouse gases.

The 24,000 MW of conventional coal-fired capacity that EIA has projected to be installed between 1998-2012 would have an electricity production efficiency of approximately 37%. While the efficiencies of the 4,000 MW of electricity generating CCT's that are anticipated to be installed as a result of the tax incentives would range from 39 to 46%. The greater the efficiency, the lower the amount of emissions for the same amount of electricity produced. Installation of CCT's as opposed to conventional coal-fired technology would result in a reduction of carbon emissions of 1.2 million tonnes by 2008 and 10.7 million tonnes by 2021.

If a sufficient number of early commercial applications of the electricity generating CCT's were to occur and the technologies reached the anticipated level of economic and technical performance, it is reasonable to assume that they would account for a significant portion of the replacement and new generating capacity that would be installed globally. The global impact of these installations would be to reduce carbon emissions by an amount proportional to their improvement in efficiency over conventional technology that would otherwise be installed.

The EIA⁴ projects that total world carbon emissions were 5.8 billion metric tons in 1990 and will increase to 10.5 billion metric tons by 2020. If deployment of CCT's in the industrialized countries and the developing countries of Asia and Africa resulted in capacity additions equal to (1) 10% of the coal supplied energy utilized in 2010, (2) 50% of capacity additions between 2010 and 2015 and (3) 75% of the additions between 2015 and 2020, annual total world carbon emissions could be reduced by 294 million metric tons in 2020 with further decreases each year in which deployment increased. This is approximately a 3% reduction of world carbon emissions and is equivalent to 25% (294/1180) of the reduction required from developed countries in 2020 under provisions similar to those of the Kyoto Protocol. This reduction projection does not consider generating capacity that will be retired and replaced with advanced technologies, which would provide further reductions in carbon emissions. The attached graph and summary table provides an estimate of world carbon emissions on a regional basis for a business-as-usual case and a deployment of CCT's case.

Research Vision for the Early Commercial Applications of Clean Coal Technology:

The government and industry must work together to support an appropriate balance of short-term and long-term activities required to develop and commercialize technology which will permit the economic, efficient, and environmentally compatible use of coal. This can be accomplished through a sustained collaborative effort between private industry and government.

Collaboration can best be achieved through communication, cooperation, and education in the design and execution of a targeted R&D program that focuses on

⁴ Energy Information Administration, International Energy Outlook 1998 With Projections through 2020, Washington DC, April 1998.

assisting the development and commercialization of coal utilization technologies. With limited financial resources, government and industry can leverage available funds through such a collaborative effort. U.S. based technological progress will be vital for satisfying domestic and global energy and environmental needs, while supporting domestic economic well being.

The current portfolio of DOE Fossil Energy programs should continue to be funded with additional emphasis on those programs that will have the greatest impact on:

- efficiency, (e.g. ATS, HIPPS, Ultra-Supercritical Steam Cycle, IGCC and advanced PFBC); and
- component reliability of operation for such technologies as high temperature particulate filters, hot gas desulfurization, coal feed/ash withdrawal, syngas burners for advanced PFBC's and IGCC'S, and material technology.

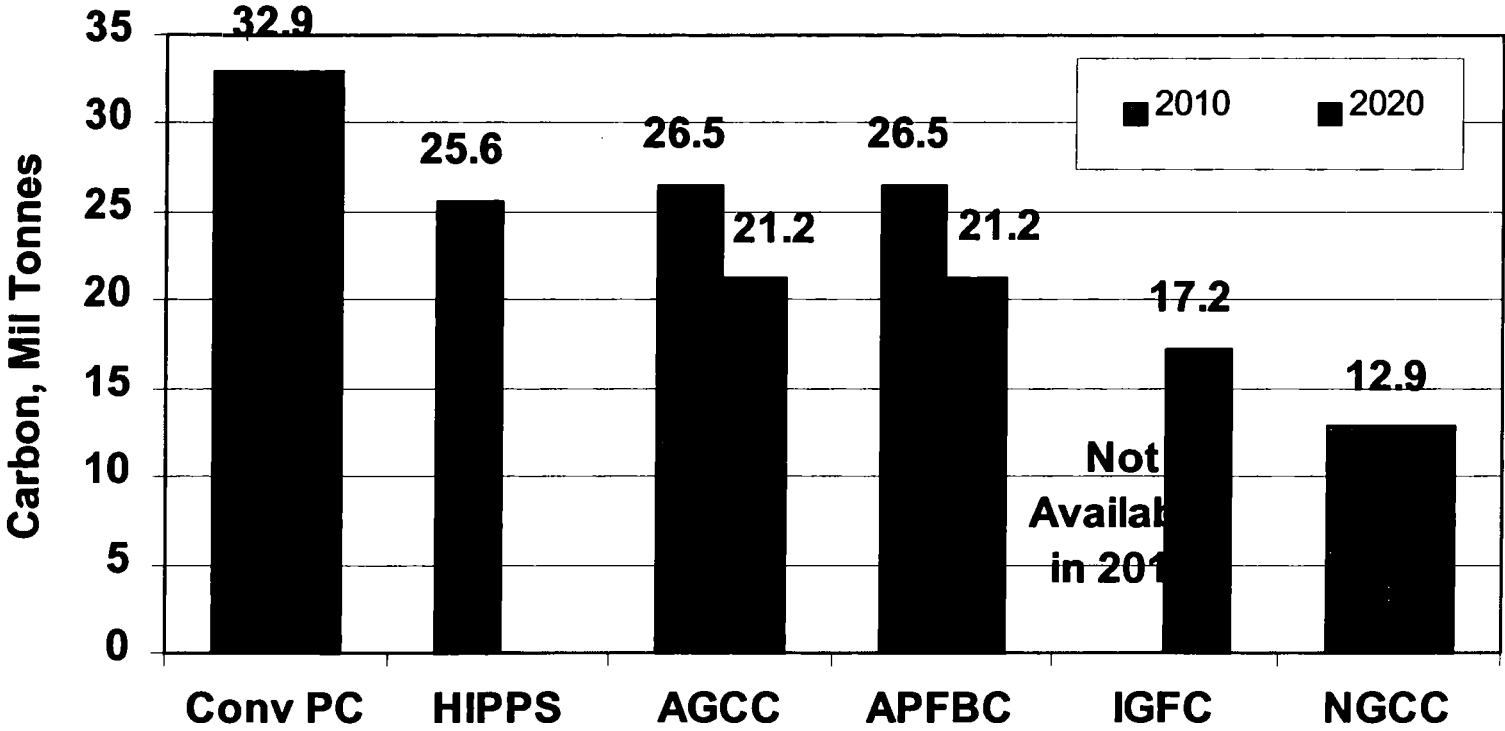
Budget Implications for the Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology:

The potential timeframes in which the CCT's in the current DOE portfolio could be displayed are shown in attachment B. The specific schedules for accomplishing the development of each program element is primarily a function of budget resources.

Presently, it is not possible to relate the DOE's budget to attachment B and make meaningful judgments as to how budget reallocations or additions would affect the availability of each CCT. The main emphasis here will be on efficiency, reliability and cost.

The DOE should develop its budget for fossil R&D in terms of the elements and timeframes shown in attachment B so that a common baseline is established for the CCT program. DOE should recast and explain its current program/budget and schedule within the appropriate timeframes so that recommendations can be made for changes to the FY 2000 budget in the near term.

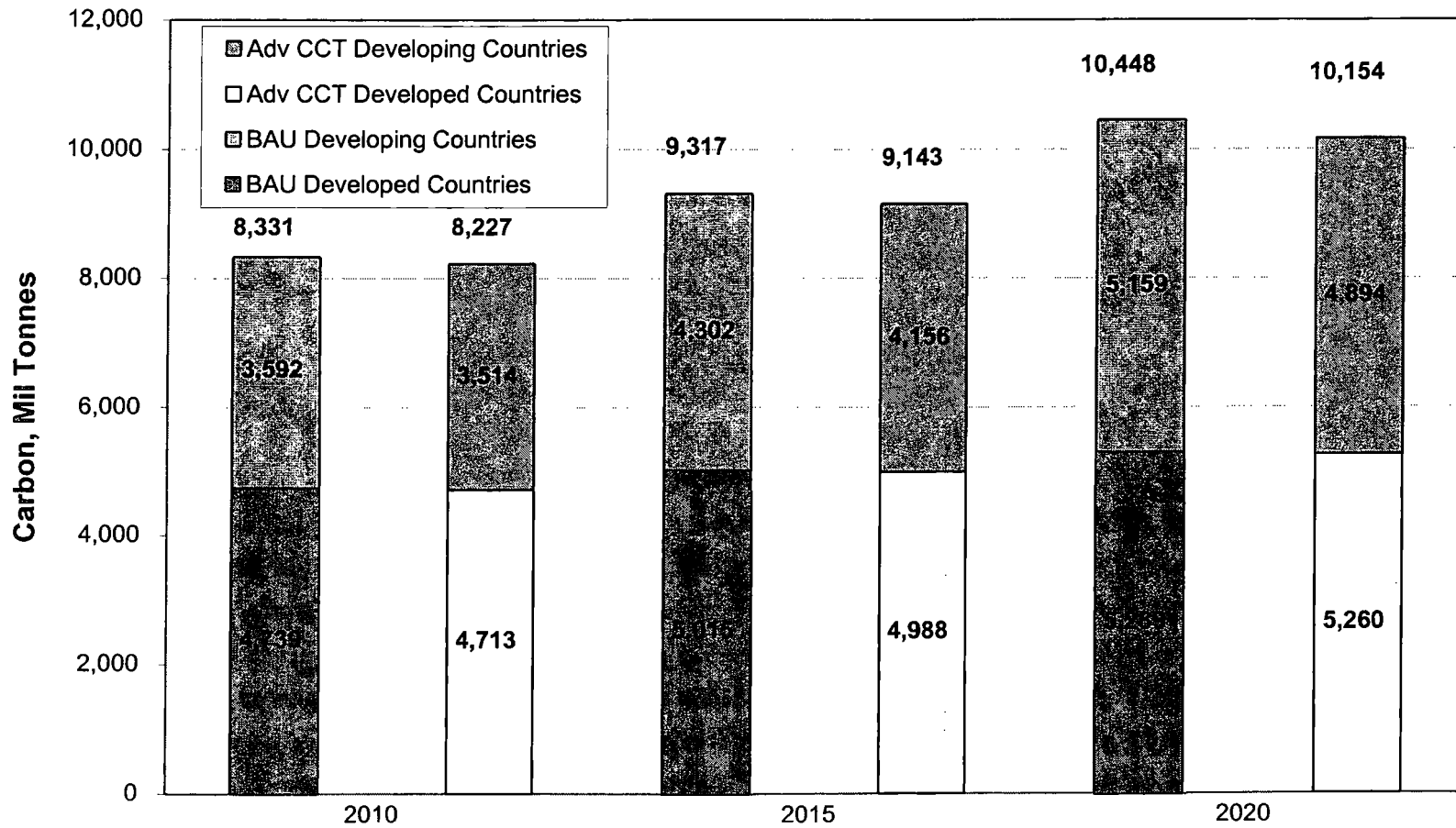
Life Cycle Carbon Emissions From Clean Coal Technologies



Technologies Commercially Available in 2010 and 2020

Life Cycle Carbon Emissions from Clean Coal Technologies						
Technology				TODAY	2010	2020
Advanced Pulverized Coal-Fired Combustion						
	Capacity, MW			450	450	Not
	Capacity Factor			85	85	Available
	Design Efficiency, % HHV			37	45	
	Design Heat Rate, Btu/kWh HHV			9300	7500	
	Carbon Emissions,	Mil Tonnes/Year		0.82	0.66	
		Mil Tonnes/40 Yr Life		32.89	26.52	
		Difference from Today			6.37	
High Performance Power Systems (Externally Fired Heat Exchanger)						
	Capacity, MW				450	Not
	Capacity Factor				85	Available
	Design Efficiency, % HHV				47	
	Design Heat Rate, Btu/kWh HHV				7250	
	Carbon Emissions,	Mil Tonnes/Year			0.64	
		Mil Tonnes/40 Yr Life			25.64	
		Difference from Today			7.25	
Gasification Combined Cycle						
					Advanced	Hybrid
	Capacity, MW			450	450	450
	Capacity Factor			85	85	85
	Design Efficiency, % HHV			41	45	57
	Design Heat Rate, Btu/kWh HHV			8200	7500	6000
	Carbon Emissions,	Mil Tonnes/Year		0.72	0.66	0.53
		Mil Tonnes/40 Yr Life		29.00	26.52	21.22
		Difference from Today			6.37	11.67
Pressurized Fluidized Bed Combustion						
					Advanced	Hybrid
	Capacity, MW			450	450	450
	Capacity Factor			85	85	85
	Design Efficiency, % HHV			40	45	57
	Design Heat Rate, Btu/kWh HHV			8500	7500	6000
	Carbon Emissions,	Mil Tonnes/Year		0.75	0.66	0.53
		Mil Tonnes/40 Yr Life		30.06	26.52	21.22
		Difference from Today			6.37	11.67
Integrated Gasification Fuel Cell						
	Capacity, MW			Not	Not	450
	Capacity Factor			Available	Available	85
	Design Efficiency, % HHV					70
	Design Heat Rate, Btu/kWh HHV					4875
	Carbon Emissions,	Mil Tonnes/Year				0.43
		Mil Tonnes/40 Yr Life				17.24
		Difference from Today				15.65
Natural Gas Fired Combine Cycle						
	Capacity, MW			450	450	450
	Capacity Factor			85	85	85
	Design Efficiency, % HHV			49	52	52
	Design Heat Rate, Btu/kWh HHV			7000	6500	6500
	Carbon Emissions,	Mil Tonnes/Year		0.35	0.32	0.32
		Mil Tonnes/40 Yr Life		13.92	12.92	12.92
		Difference from Today			19.96	19.96

Impact of Advanced Clean Coal Technology on World Carbon Emissions



Impact of Advanced Clean Coal Technologies on World Carbon Emissions				
		2010	2015	2020
Developed Countries				
North America				
	Business As Usual Carbon Emissions, Mil Tonnes	2,105	2,217	2,313
	Coal Energy Supplied by Advanced Clean Coal	10%	11%	13%
	Carbon Emissions with Advanced CCT, Mil Tonnes	2,092	2,201	2,293
	Carbon Reduction, Mil Tonnes/Year	13	16	20
Western Europe				
	Business As Usual Carbon Emissions, Mil Tonnes	1,101	1,169	1,239
	Coal Energy Supplied by Advanced Clean Coal	10%	10%	10%
	Carbon Emissions with Advanced CCT, Mil Tonnes	1,096	1,164	1,234
	Carbon Reduction, Mil Tonnes/Year	5	5	5
Asia/Pacific				
	Business As Usual Carbon Emissions, Mil Tonnes	461	485	514
	Coal Energy Supplied by Advanced Clean Coal	10%	11%	12%
	Carbon Emissions with Advanced CCT, Mil Tonnes	459	482	511
	Carbon Reduction, Mil Tonnes/Year	2	3	3
Eastern Europe/Former Soviet Union				
	Business As Usual Carbon Emissions, Mil Tonnes	1,072	1,144	1,223
	Coal Energy Supplied by Advanced Clean Coal	10%	8%	5%
	Carbon Emissions with Advanced CCT, Mil Tonnes	1,066	1,139	1,222
	Carbon Reduction, Mil Tonnes/Year	6	5	1
Total Developed Countries				
	Business As Usual Carbon Emissions, Mil Tonnes	4,739	5,015	5,289
	Coal Energy Supplied by Advanced Clean Coal	10%	10%	10%
	Carbon Emissions with Advanced CCT, Mil Tonnes	4,713	4,988	5,260
	Carbon Reduction, Mil Tonnes/Year	26	27	29
Developing Countries				
Asia/Pacific				
	Business As Usual Carbon Emissions, Mil Tonnes	2,603	3,158	3,835
	Coal Energy Supplied by Advanced Clean Coal	10%	17%	28%
	Carbon Emissions with Advanced CCT, Mil Tonnes	2,572	3,086	3,660
	Carbon Reduction, Mil Tonnes/Year	31	72	175
Middle East				
	Business As Usual Carbon Emissions, Mil Tonnes	322	363	409
	Coal Energy Supplied by Advanced Clean Coal	0%	0%	0%
	Carbon Emissions with Advanced CCT, Mil Tonnes	315	344	388
	Carbon Reduction, Mil Tonnes/Year	7	19	21
Africa				
	Business As Usual Carbon Emissions, Mil Tonnes	276	306	341
	Coal Energy Supplied by Advanced Clean Coal	10%	12%	17%
	Carbon Emissions with Advanced CCT, Mil Tonnes	245	274	302
	Carbon Reduction, Mil Tonnes/Year	31	32	39
Central & South America				
	Business As Usual Carbon Emissions, Mil Tonnes	391	475	574
	Coal Energy Supplied by Advanced Clean Coal	0%	0%	0%
	Carbon Emissions with Advanced CCT, Mil Tonnes	382	452	545
	Carbon Reduction, Mil Tonnes/Year	9	23	29
Total Developing Countries				
	Business As Usual Carbon Emissions, Mil Tonnes	3,592	4,302	5,159
	Coal Energy Supplied by Advanced Clean Coal	10%	17%	27%
	Carbon Emissions with Advanced CCT, Mil Tonnes	3,514	4,156	4,894
	Carbon Reduction, Mil Tonnes/Year	78	146	265
Total World				
	Business As Usual Carbon Emissions, Mil Tonnes	8,331	9,317	10,448
	Coal Energy Supplied by Advanced Clean Coal	10%	14%	21%
	Carbon Emissions with Advanced CCT, Mil Tonnes	8,227	9,143	10,154
	Carbon Reduction, Mil Tonnes/Year	104	174	294

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FINANCIAL ANALYSIS

Divider Title: _____

Attachment A

Financial Analysis of Tax Credits and Risk Pool Appropriation Requirements

The financial analysis examines the level of tax credits that would be required to have a developer of electricity generating capacity to undertake an early commercial application of an emerging clean coal technology (CCT). The level of tax credits required is determined through a comparison of the revenue requirements for building and operating a CCT plant and a natural gas-fired combined cycle (NGCC) plant. The NGCC plant, in many applications in the US, represents the electricity generating technology that has the lowest capital costs and produces the lowest cost electricity. This comparison is intended to be a "first-look" at this question with only first order effects being modeled and the assumptions have not been refined beyond that point.

The average price per MWh was calculated for the NGCC plant to produce an internal rate of return for the project cash flows, after taxes, which is equal to the weighted average cost of capital after taxes. The weighted average cost of capital reflects a 10% interest rate for debt, 25% owner's equity and a required rate of return on equity of 18%. The results of this calculation are shown for NGCC plants that begin operation in 2004, 2008 and 2012.

The CCT's are currently in the early stage of commercialization and as a result have higher capital and operating costs and exhibit a higher level of risk associated with achieving its design performance. In order to encourage a developer to install a CCT, financial incentives must be offered to overcome the inherently higher financial and operating risk of an emerging technology. The financial incentives must be great enough for the CCT to compete with the lowest cost alternative energy source. In this analysis, that is assumed to be a NGCC plant.

To determine the required level of financial incentives, the present value of the cash flows for each CCT assumed to be installed are calculated assuming that the average price of electricity is the same as for the NGCC plant. The cash flow from the CCT is increased by the application of an investment tax credit and a production tax credit until the internal rate of return of the cash flows is equivalent to the weighted average cost of capital after taxes.

To determine the impact of the financial incentives on tax revenues, the analysis assumes that one each of three different CCT's would be installed in 2004. These would be one 500MW advanced pulverized coal-fired plant (AdvPCF2004), one 500MW pressurized fluidized bed plant (PFBC) and one 500MW integrated gasification combined cycle plant (IGCC). It takes approximately 3 years to build a CCT plant and that is why no plants begin operation before 2004. In order to benefit from the experience gained from the first units, the second set of the same technologies are

assumed to begin operation in 2008. The final 2 installations begin operation in 2012, but only a PFBC and an IGCC unit are assumed to be installed because AdvPCF is assumed to have reached its maximum level of performance with the 2008 installation.

A third and equally necessary financial incentive (the "Risk Pool") is also calculated for each installation. The Risk Pool is to be established by appropriations from the U.S. government and authorized only if a qualifying CCT plant could not meet its design performance and had to be modified during the initial start-up or first 3 years of operation. The level of federal funding would be limited to 5% of the installed capital costs of the plant. The values of the tax incentives and risk pool are discounted to 1998 dollars at the current 30-year Treasury bill rate of 6%.

Attachment A
Financial Analysis of Tax Credits and Risk Pool Appropriation Requirements

Tax Revenue, Appropriations and Environmental Impacts - Electricity Production																				4/17/98	
				1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2021
Technology	Installed Capacity MW	Installed Cost \$/KW																			
Tax Revenue Impacts, \$x000																					
Adv PCF																					
Investment Tax Credit	500	1,150						\$37,335													
Production Tax Credit									\$29,565	\$29,565	\$29,565	\$29,565	\$29,565	\$29,565	\$22,995	\$22,995	\$22,995	\$22,995	\$22,995	\$22,995	\$22,995
Investment Tax Credit	500	1,095											\$38,480								
Production Tax Credit														\$22,995	\$22,995	\$22,995	\$22,995	\$22,995	\$22,995	\$18,068	\$18,068
PFBC																					
Investment Tax Credit	500	1,250						\$40,582													
Production Tax Credit									\$32,850	\$32,850	\$32,850	\$32,850	\$32,850	\$32,850	\$27,923	\$27,923	\$27,923	\$27,923	\$27,923	\$27,923	\$27,923
Investment Tax Credit	500	1,190											\$41,818								
Production Tax Credit														\$26,280	\$26,280	\$26,280	\$26,280	\$26,280	\$26,280	\$21,353	\$21,353
Investment Tax Credit	500	1,130																			
Production Tax Credit																				\$42,983	\$14,783
IGCC																					
Investment Tax Credit	500	1,300						\$42,205													
Production Tax Credit									\$42,705	\$42,705	\$42,705	\$42,705	\$42,705	\$42,705	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778
Investment Tax Credit	500	1,205											\$42,345								
Production Tax Credit														\$32,850	\$32,850	\$32,850	\$32,850	\$32,850	\$32,850	\$26,280	\$26,280
Investment Tax Credit	500	1,145																			
Production Tax Credit																				\$43,554	\$22,995
Total Revenue Impact																					
Investment Tax Credit	4,000	1,183						\$120,122	\$0	\$0	\$0	\$122,644	\$0	\$0	\$0	\$0	\$86,537				
Production Tax Credit									\$105,120	\$105,120	\$105,120	\$105,120	\$187,245	\$170,820	\$170,820	\$170,820	\$221,738	\$205,313	\$116,618	\$37,778	\$37,778
Total								\$120,122	\$105,120	\$105,120	\$105,120	\$227,764	\$187,245	\$170,820	\$170,820	\$257,357	\$221,738	\$205,313	\$116,618	\$37,778	\$37,778
Total Revenue Impact (1998\$, Discounted @ T-Bill rate of 6%)																					
Investment Tax Credit								\$89,762	\$0	\$0	\$0	\$72,593	\$0	\$0	\$0	\$40,572	\$0	\$0	\$0	\$0	\$0
Production Tax Credit								\$0	\$74,105	\$69,911	\$65,954	\$62,220	\$104,557	\$89,986	\$84,892	\$80,087	\$98,075	\$85,670	\$45,906	\$9,890	\$9,890
Total								\$89,762	\$74,105	\$69,911	\$65,954	\$134,813	\$104,557	\$89,986	\$84,892	\$120,659	\$98,075	\$85,670	\$45,906	\$9,890	\$9,890
Total Revenue 1999-2003 (1998\$)								\$89,762													
Total Revenue 2004-2008 (1998\$)													\$449,340								
Total Revenue 1999-2021 (1998\$)																					\$1,225,919

Attachment A
Financial Analysis of Tax Credits and Risk Pool Appropriation Requirements

Tax Revenue, Appropriations and Environmental Impacts - Electricity Production																				4/17/98
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2021	
Risk Pool Appropriations, \$x000																				
Adv PCF							\$12,445	\$12,445	\$12,445		\$12,827	\$12,827	\$12,827							
PFBC							\$13,527	\$13,527	\$13,527		\$13,939	\$13,939	\$13,939		\$14,328	\$14,328	\$14,328			
IGCC							\$14,068	\$14,068	\$14,068		\$14,115	\$14,115	\$14,115		\$14,518	\$14,518	\$14,518			
Total							\$40,041	\$40,041	\$40,041		\$40,881	\$40,881	\$40,881		\$28,846	\$28,846	\$28,846			
Total (1998\$)							\$33,619	\$33,619	\$33,619		\$34,325	\$34,325	\$34,325		\$24,219	\$24,219	\$24,219			
Total 1999-2003(1998\$)						\$0														
Total 2004-2008(1998\$)											\$135,181									
Total 1999-2021(1998\$)																			\$276,489	
Carbon Equivalents Reductions (100 Year Warming Potential), Tonnes																				
Technology	Heat Rate Btu/kWh	Thermal Efficiency																		
Conventional PCF	9,300	37%																		
Adv PCF	8,750	39%				48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	48,506	
	8,315	41%									83,288	83,288	83,288	83,288	83,288	83,288	83,288	83,288	83,288	
PFBC	8,550	40%				63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	63,417	
	8,125	42%									99,353	99,353	99,353	99,353	99,353	99,353	99,353	99,353	99,353	
	7,720	44%													133,598	133,598	133,598	133,598	133,598	
IGCC	8,400	41%				76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	76,100	
	7,770	44%									129,371	129,371	129,371	129,371	129,371	129,371	129,371	129,371	129,371	
	7,380	46%													162,347	162,347	162,347	162,347	162,347	
Total Reduction							186,023	186,023	186,023	186,023	498,034	498,034	498,034	498,034	793,980	793,980	793,980	793,980	793,980	
1999-2003						0														
2004-2008											1,242,126									
1999-2021											471								10,676,028	
\$/Tonne																			141	

NGCC 500 MW Plant (2012)																4/17/98	
capacity		500	MW	capital carrying charges		13.50%											
heat rate		6300	Btu/kWh	depreciation		Straight Line											
fuel cost		\$2.64	/mmBtu	initial cost		\$525	/kW										
fuel escalation		3.0%		% debt financing		75%											
inflation		2.0%		cost of debt		10%											
non-fuel variable O&M		1	\$/MWh	cost of equity		18%											
fixed O&M		9	\$/kW-yr	weighted ave cost of capital		9%											
capacity factor		75%		G&A		2%											
generation		3,285,000	MWh	tax rate		34%											
book life		20	years	construction expenditure cycle													
useful life		30	years		year	1	30%										
loan term		20	years		year	2	40%										
T Bill Rate		6.0%			year	3	30%										
year		1998		Construction Period			Investment										
				-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
initial cost		\$262,500		\$97,916	\$133,165	\$101,872	\$399,402										
Revenue																	
electricity price, \$/MWh		\$36.16						\$47.71	\$48.67	\$49.64	\$50.63	\$51.65	\$52.68	\$53.73	\$54.81	\$55.90	\$57.02
revenue								\$156,735	\$159,870	\$163,067	\$166,329	\$169,655	\$173,048	\$176,509	\$180,039	\$183,640	\$187,313
Expenses																	
fuel expense								\$82,642	\$85,121	\$87,675	\$90,305	\$93,014	\$95,805	\$98,679	\$101,639	\$104,688	\$107,829
non-fuel O&M								\$4,334	\$4,421	\$4,510	\$4,600	\$4,692	\$4,786	\$4,881	\$4,979	\$5,079	\$5,180
fixed O&M								\$5,938	\$6,056	\$6,178	\$6,301	\$6,427	\$6,556	\$6,687	\$6,820	\$6,957	\$7,096
total annual production expenses								\$92,914	\$95,599	\$98,362	\$101,206	\$104,133	\$107,146	\$110,247	\$113,439	\$116,724	\$120,105
electricity production expense, \$/MWh								\$28.28	\$29.10	\$29.94	\$30.81	\$31.70	\$32.62	\$33.56	\$34.53	\$35.53	\$36.56
depreciation								\$19,970	\$19,970	\$19,970	\$19,970	\$19,970	\$19,970	\$19,970	\$19,970	\$19,970	\$19,970
G&A								\$7,988	\$7,988	\$7,988	\$7,988	\$7,988	\$7,988	\$7,988	\$7,988	\$7,988	\$7,988
total expenses								\$120,872	\$123,557	\$126,320	\$129,164	\$132,091	\$135,104	\$138,205	\$141,397	\$144,682	\$148,063
Net Income Before Taxes								\$35,863	\$36,313	\$36,747	\$37,164	\$37,564	\$37,944	\$38,304	\$38,642	\$38,958	\$39,250
taxes								\$12,193	\$12,346	\$12,494	\$12,636	\$12,772	\$12,901	\$13,023	\$13,138	\$13,246	\$13,345
Net Income after Taxes								\$23,669	\$23,966	\$24,253	\$24,528	\$24,792	\$25,043	\$25,281	\$25,504	\$25,712	\$25,905
cash flow= NI + depreciation								(\$399,402)	\$43,640	\$43,937	\$44,223	\$44,499	\$44,762	\$45,013	\$45,251	\$45,474	\$45,682
IRR									9.45%								
PV Investment									(\$308,751)								
PV NI + depreciation									\$308,794								

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R & D ROAD MAPS

Divider Title: _____

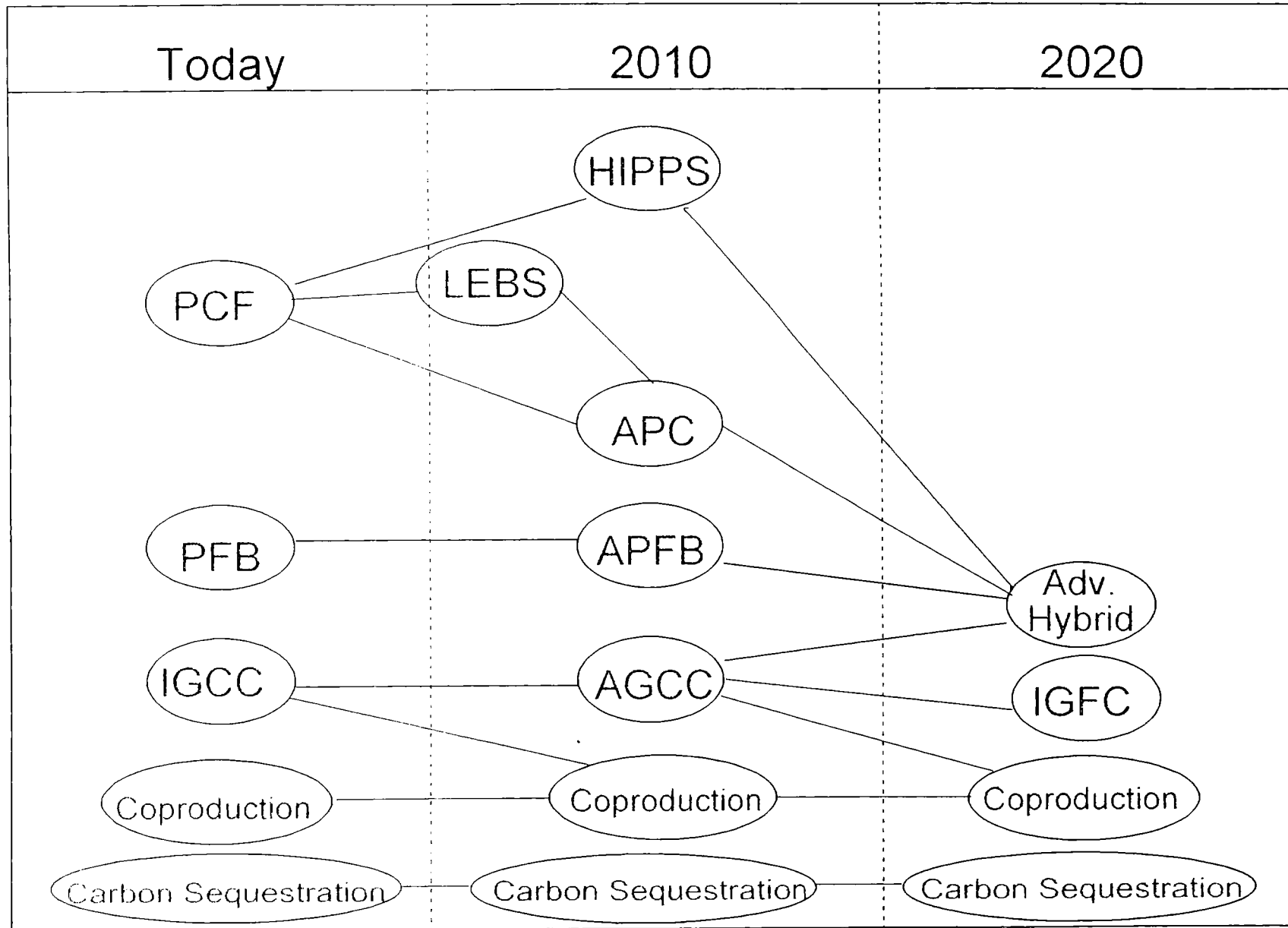
Attachment B

Research and Development Road Maps for Clean Coal Technologies

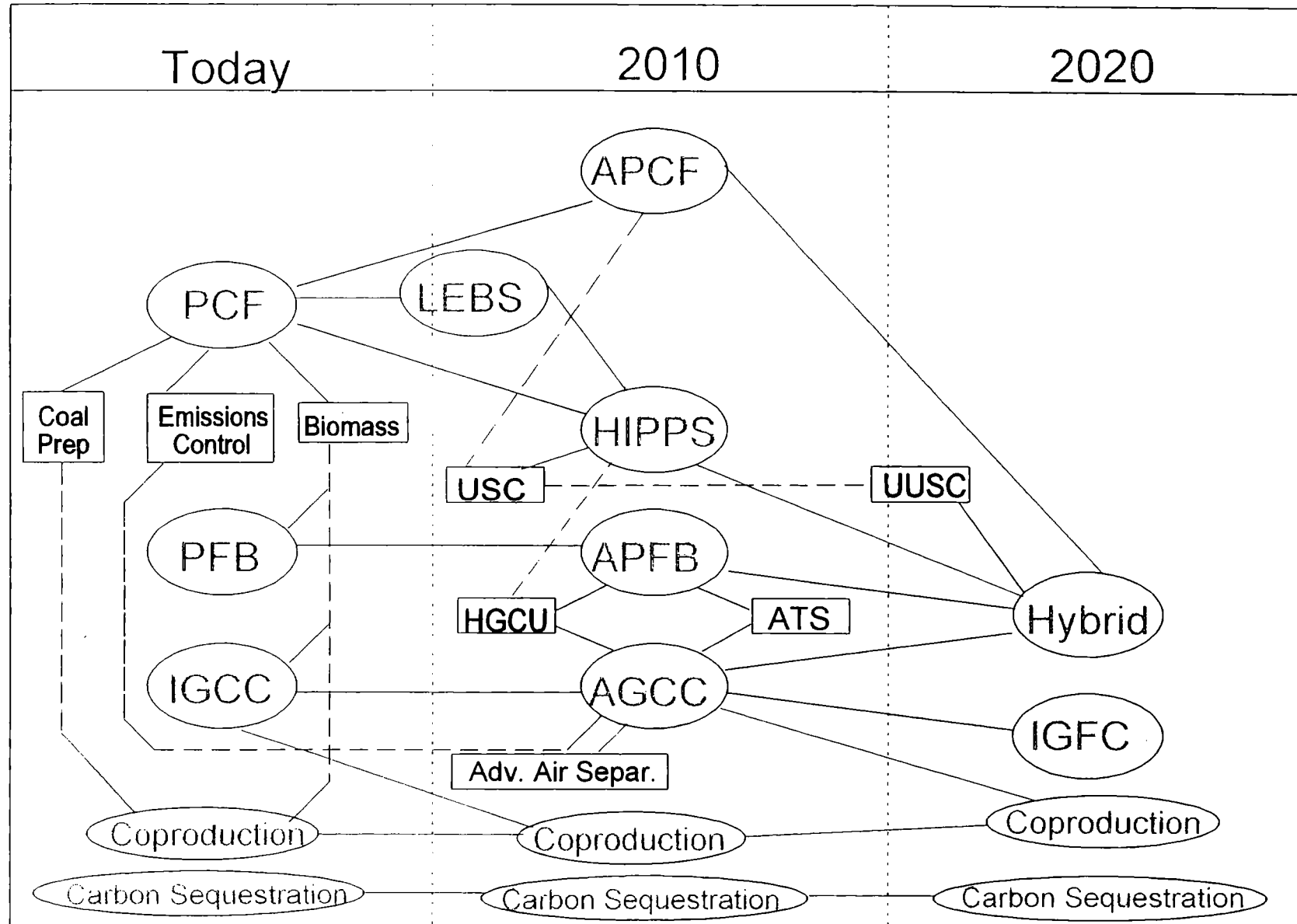
Performance Targets for Coal Generation

Performance Target	Today	2010	2020
Capital Cost, \$/kW	900 -1300	800	800
Efficiency, %HHV	40	45	50 - 60
SO ₂ , removal %	95	97	99
No _x lbs/mmbtu	0.1 - 0.3	0.08	0.05
HAPs (<i>hazardous air pollutants</i>)	define goals	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100

Coal Fired Power Plant Technologies



Coal Fired Power Plants / Enabling Technologies



Enabling technologies to build industry core competencies include materials and lifting; sensors and controls; computational fluid dynamics; coal characterization; and coal preparation.

Efficiency Goals for Coal Fired Plants

Year 2010 Goal

Year 2020 Goal

LEBS

APCF

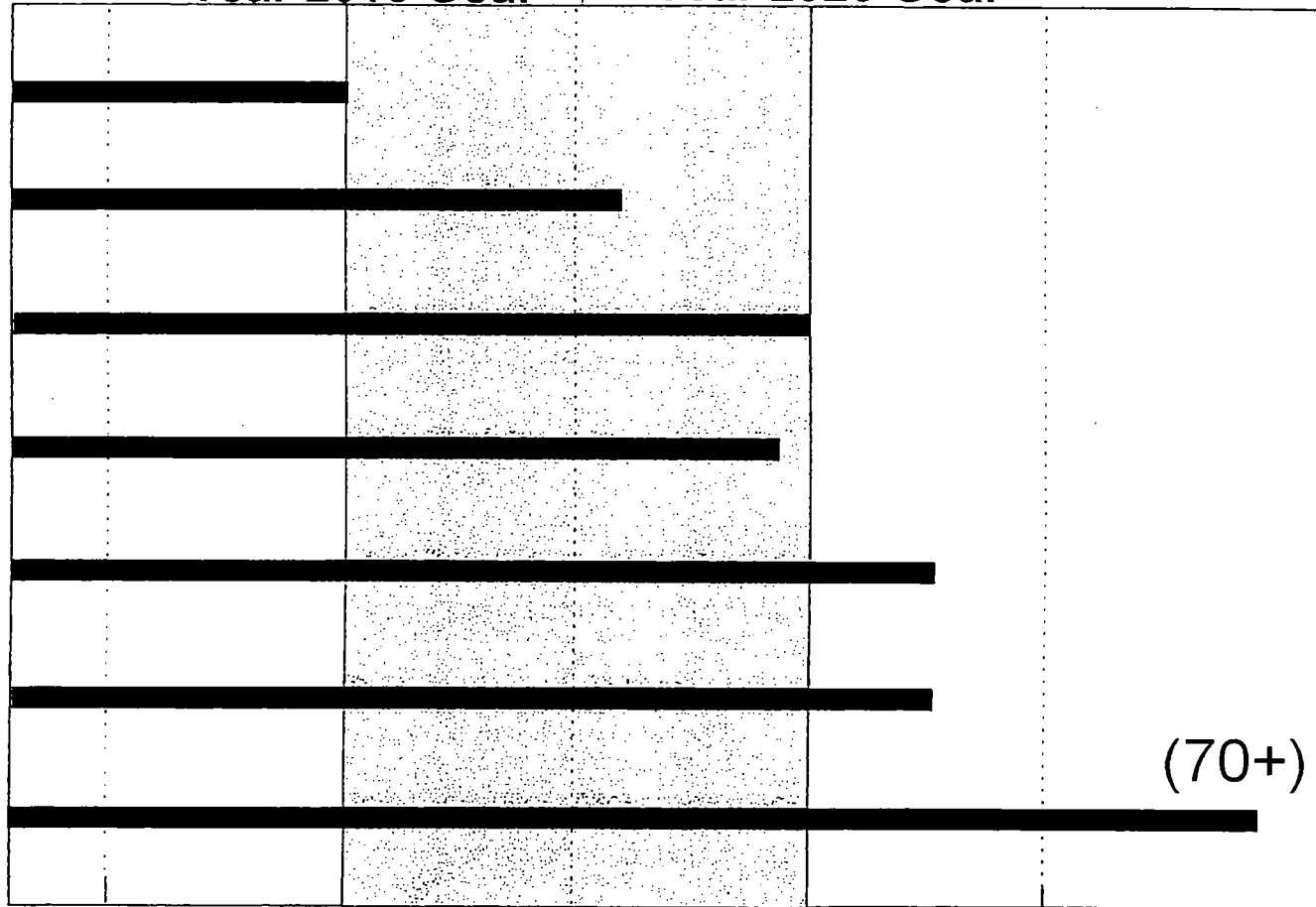
HIPPS

APFB

AGCC

Hybrid

IGFC



(70+)

40

45

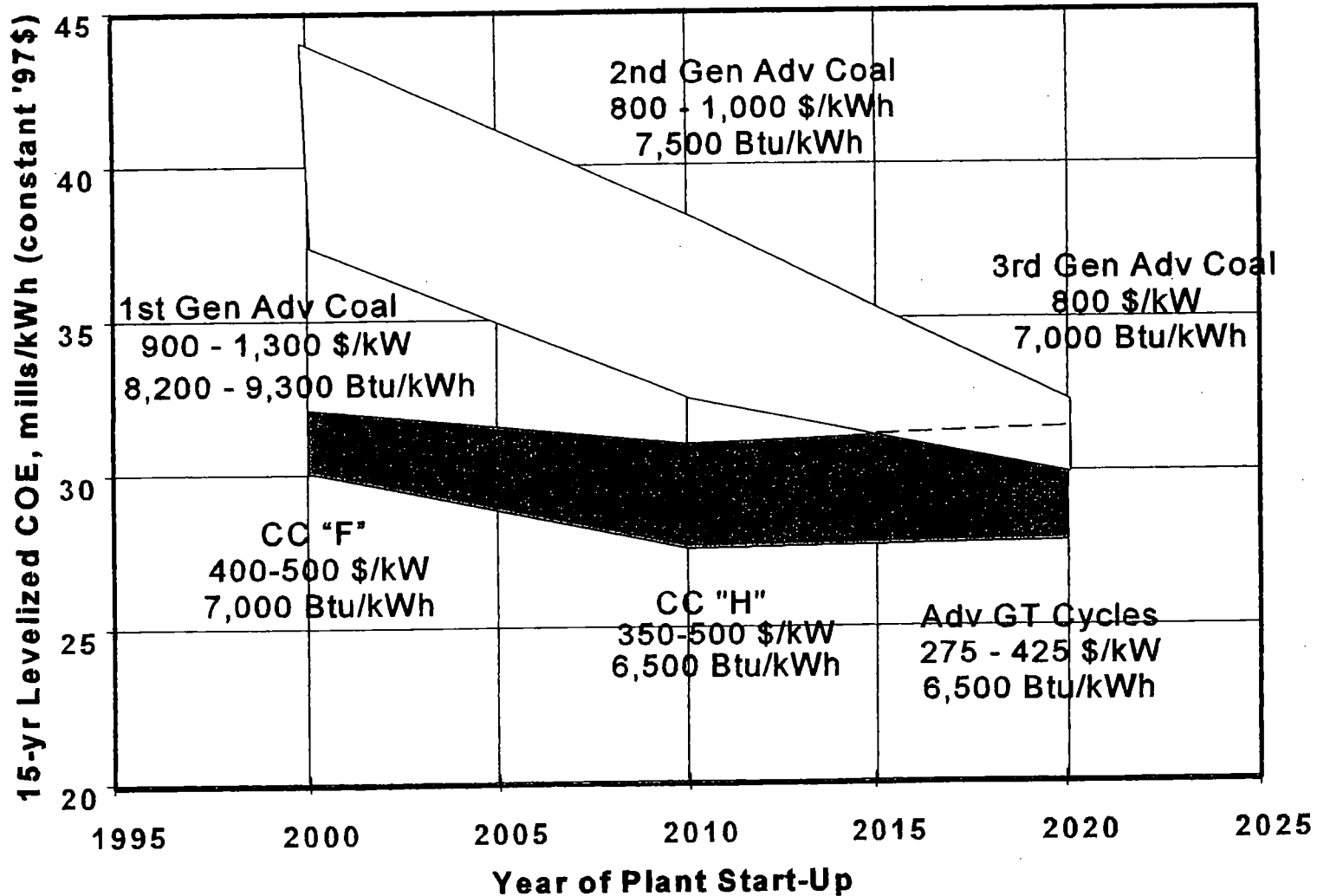
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55

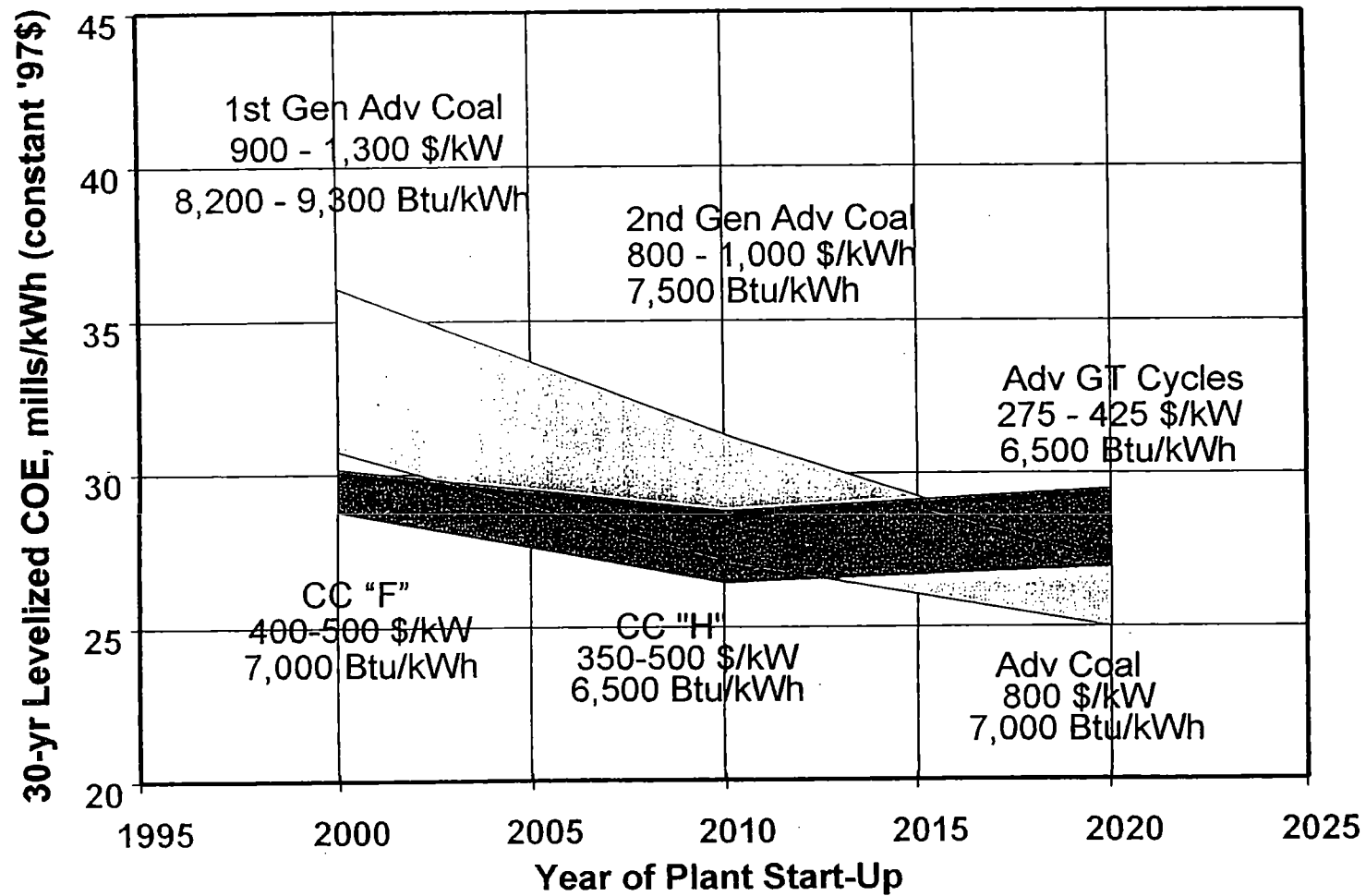
60

Efficiency, %HHV

15-Year Levelized Cost of Electricity for Coal Fired v. Gas Fired Power Technologies



30-Year Levelized Cost of Electricity for Coal Fired vs. Gas Fired Power Technologies



AGCC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	1200-1300	800	800
Efficiency, %HHV	40	45	57*
SO ₂ removal, %	99 (cold)	97 (hot)	99 (hot)
NO _x lbs/mmbtu	0.06	0.06	0.05
HAPs	define goals	meet goals	meet goals
Waste Utilization, %	30	75	100
Equivalent Availability, %	90	90	90

*GCC/PFB Hybrid

AGCC Technology Trajectories

Technology Need	Today	2010	2020
Gas Cleanup	cold	hot -- 1000°F 8,000-20,000 hrs by 2005	hot -1500°F 20,000 hours
Combustion Turbine	"F" 2350°F	ATS -- 2750°F plus combustor development	Advanced CT cycles
Steam Cycle	Subcritical	Subcritical	Ultrasupercritical Steam
Oxidant	O ₂	Air or O ₂ with advanced air separation	Air or O ₂ with advanced air separation
SO ₂ removal	cold	hot with external desulfurization	hot
Waste Utilization, %	15 - 30	50 - 75	100

APFBC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	900 -1100	800	800
Efficiency, % HHV	40	45	57*
SO ₂ removal, %	95	97	99
NO _x , lbs/mmbtu	0.1	0.08	0.05
Equivalent Availability, %	90	90	90

* GCC/PFB Hybrid

APFBC Technology Trajectories

Technology Need	Today	2010	2020
HTHP Filters	Cyclones	1600°F oxidizing conditions	1700°F oxidizing conditions
Combustion Turbine	"F"- 2350°F rugged	ATS-- 2750°F advanced combustor	Advanced CT cycles
Steam Cycle	2400psi/1050°F single reheat	3500psi/1050°F single reheat	5000psi/1300°F double reheat
Sulfur removal	dolomite	flue gas polishing	flue gas polishing
HAPs	define goals (trace)	meet goals	meet goals
Waste Utilization, %	15 - 30	50 - 75	100

IGFC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	n/a	n/a	800+
Efficiency, %HHV	n/a	n/a	70+
SO ₂ removal, %	n/a	n/a	99+
NO _x , lbs/mmbtu	n/a	n/a	< 0.05
HAPs	n/a	n/a	meet goals
Waste Utilization, %	n/a	n/a	100
Equivalent Availability %	n/a	n/a	90

IGFC Technology Trajectories

Technology Need	Today	2010	2020
Fuel Utilization	natural gas fuel cells	coal gas fuel cells	large coal gas fuel cells
Plant Scale-Up	250kw to 1MW demos	2 to 50MW demos	200-400MW commercial plants
Hot Gas Clean-Up	see GCC	see GCC	as required to maintain fuel cell life
SO2 removal	see GCC	see GCC	as required to maintain fuel cell life
Integration	n/a	CT/Fuel Cell Integration	integration of gasifier hot-gas clean-up, and fuel cell

HIPPS Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	n/a	800	800
Efficiency, %HHV	n/a	47	55
SO ₂ removal, %	n/a	99	99
NO _x , lbs/mmbtu	n/a	0.06	0.05
HAPs	n/a	meet goals	meet goals
Waste Utilization, %	n/a	some	100
Equivalent Availability, %	n/a	90	90

HIPPS Technology Trajectories

Technology Need	Today	2010	2020
High Temperature / High Pressure Filter	n/a	1100°F reducing	1800°F reducing
Heat Exchanger	n/a	1800°F (Alloy)	2750°F (ceramic)
Steam Cycle	n/a	4000psi/ 1200°F double reheat	5000psi/ 1300°F double reheat
Steam Turbine	n/a	cycle design, aerodynamics, materials	cycle design, aerodynamics, materials
Gas Turbine	n/a	Humid air turbine	Humid air turbine 2750°
Particulate	n/a	to be defined	to be defined

Advanced PC Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	1100	800	800
Efficiency, % HHV	41	45	47-51
SO ₂ removal, %	97	98	99
NO _x , lbs/mmbtu	0.1	0.08	0.05
HAPs	define goals	mercury control	meet goals
Waste Utilization, %	15 - 30	50 - 75	100
Equivalent Availability, %	90	90	90

Advanced PC Technology Trajectories

Technology Need	Today	2010	2020
Steam Cycle Conditions	3500 psi/1050°F Double reheat	4000 psi/1200°F Double reheat	5000 psi/1300°F Double reheat
Boiler and Steam Cycle Materials	ferritics, austenitics	ferritics, austenitics, Ni-based alloys	new Ni-based alloys
Steam Turbine	n/a	plant cycle integration, materials	new aerodynamics, cycle integration, materials
SO₂ removal	n/a	integrated with HAPS & particulate control	integrated with HAPS & particulate control
NO_x control	burners, SCR	Adv. burners, SCR	Adv. burners, SCR

Crosscutting Enabling Technology

Technology	2010	2020
High Temperature/ High Pressure Filters		
AGCC	1000°F reducing	1500°F reducing
APFB	1600°F reducing	1700°F reducing
HIPPS	1100°F reducing	1500°F reducing
IGFC	n/a	1000°F reducing
Combustion Turbine		
AGCC	2750°F — ATS	Advanced Cycle
APFB	2750°F — ATS	Advanced Cycle
HIPPS	n/a	2750°F
Steam Cycle Materials		
APFB	n/a	New Alloys, 1300°F
APC	Ferritics, new alloys	New Alloys, 1300°F
HIPPS	n/a	New Alloys, 1300°F
HAPS	Address issues as characterized by 2000 for all technologies	Address

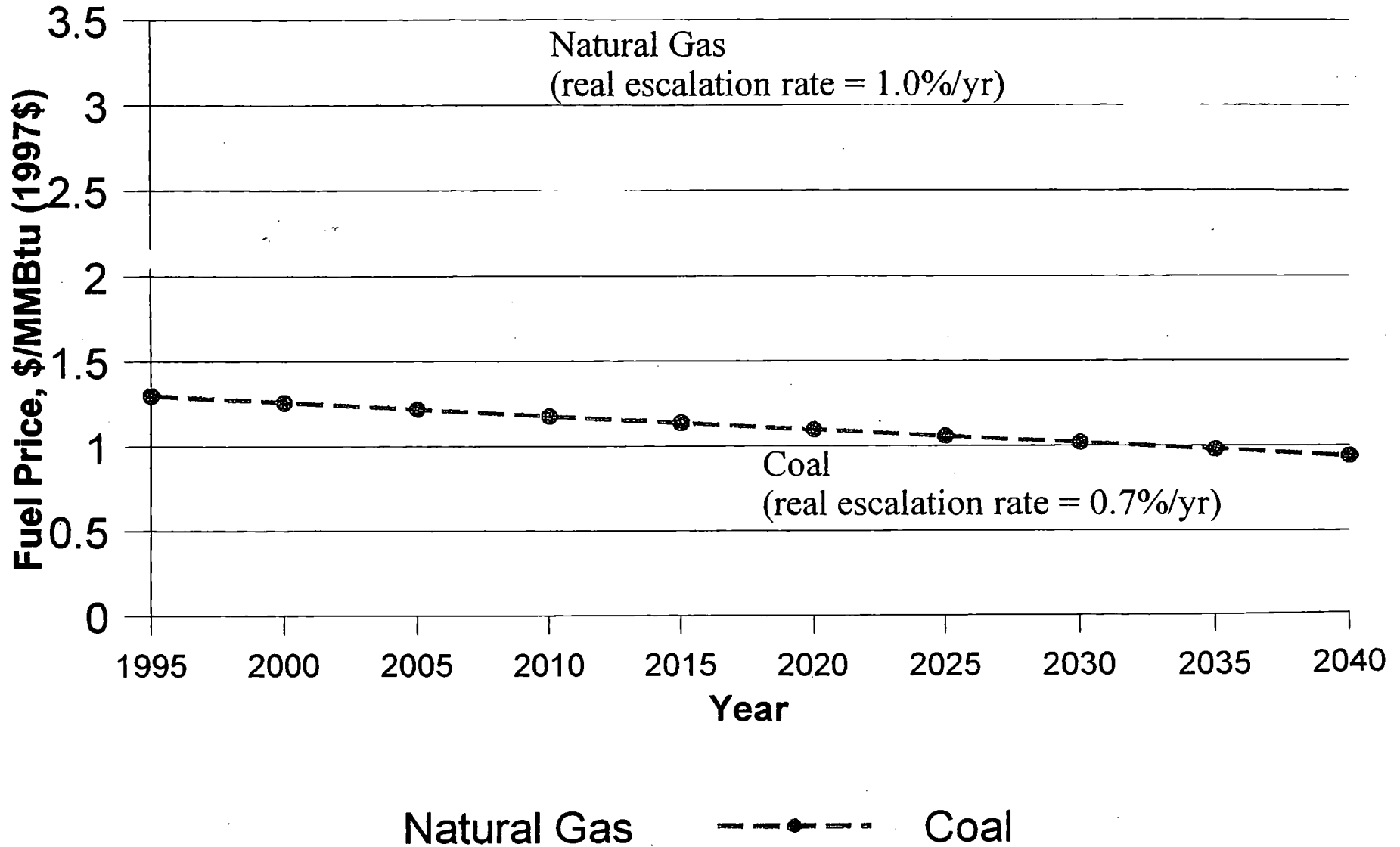
Crosscutting Enabling Technology

Technology	2010	2020
Hot Sulfur Cleanup		
AGCC	External Hot Desulfurization	External Hot Desulfurization
APFB	n/a	Polishing
IGFC	n/a	External Hot Desulfurization Polishing
NOx Removal		
AGCC	n/a	n/a
APFB	n/a	n/a
IGFC	n/a	n/a
HIPPS	Advanced Cost Efficient NOx Removal	Advanced Cost Efficient NOx Removal
Air Separation		
AGCC	Advanced Air Separation	Advanced Air Separation
APFB	Advanced Air Separation	Advanced Air Separation
IGFC	Advanced Air Separation	Advanced Air Separation
HIPPS	n/a	n/a

Assumptions Used to Determine COE in Comparison Charts

Region	SE	SE	SE	SE	SE	SE	SE	SE
Technology	Adv PFBC	Adv IGCC	IGCC "F"	IGCC "H"	IGCHAT	CC "F"	CC "H"	Adv CHAT
Plant Size, MW	680	460	570	450	450	225	400	400
Capacity Factor, %	85	85	85	85	85	85	85	85
Fuel	Coal	Coal	Coal	Coal	Coal	Gas	Gas	Gas
Fuel Cost in yr 2000, \$MMBtu	1.29	1.29	1.29	1.29	1.29	2.24	2.24	2.24
Fuel Real Esc. Rate, %/yr	-0.07	-0.07	-0.07	-0.07	-0.07	1	1	1
Total Plant Cost, \$/kW	800	800	1310	1150	810	400	350	270
Fixed O&M, \$/kW-yr	26.9	35.4	43.8	38.4	35.4	13.3	10.3	10.3
Var. O&M, mills/kWh	2	1.5	1.3	1.3	1.5	3.1	2.2	2.2
Heat Rate, Btu/kWh HHV	7240	7000	8200	7500	7000	7000	6500	6500
<p>Note: Total Plant Costs are typical values. They vary depending on plant size and design, plant location, etc.</p> <p>Fuel Costs are based on EIA's 1997 AEO Projections (National Average)</p>								

Fuel Price Projections Based on AEO '97



Glossary of Acronyms

ATS	Advanced (gas) turbine system
AGCC	Advanced gasification combined cycle
APCF	Advanced pulverized Coal fired plant
APFB	Advanced pressurized fluid bed
CC	Combined cycle
HAPs	Hazardous air pollutants
HIPPS	High performance power system
HGCU	Hot gas cleanup
HHV	Higher heating value
IGCC	Integrated gasification combined cycle
IGFC	Integrated gasification fuel cell
LEBS	Low emission boiler system
PCF	Pulverized coal fired plant
PFB	Pressurized fluid bed
USC	Ultra supercritical
UUSC	Ultra, ultra supercritical