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Folder Title:
Clean Coal [2]

Stack:	Row:	Section:	Shelf:	Position:
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DRAFT

Clean Coal Technology Budget and Tax Incentives Meeting

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

I. Welcome and Introductions
(10 Minutes)

Franz Wuerfmannsdobler
Office of Senator Byrd

II. FY 2000 R&D Budget for clean coal funding
(15 Minutes)

(Administration official)

III. Energy challenges and fuel diversity
(10 Minutes)

Charles Goodman
Southern Company

IV. CURC's R&D Roadmap
A. Industry reaction to DOE's initiatives
(10 Minutes)

Ben Yamagata
CURC

V. Incentives for early commercial application of CCT
A. CCT tax incentives
B. Revenue requirements
C. International options
D. Carbon sequestration reduction potential
(20 Minutes)

John Wootten
Peabody Group

VI. Questions & Answers
(20-30 Minutes)

Franz Wuerfmannsdobler
Office of Senator Byrd

VII. Future activities

All

- Cancer

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- ~~Have~~ ^{reviewing} ~~some~~ meeting

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Todd Stern

Dirk Forrister

Linda Lance

Geri Gerardi

Len Burman

Melanie Kenderdine

Bob Kripowicz

Julie Anderson

Roger Ballentine

White House

Climate Change Task Force

Council on Environmental Quality

Treasury Department

Treasury Department

Department of Energy - Office of the Secretary

Department of Energy - Acting Asst. Secretary

Climate Change Task Force

White House Legislative Affairs

Senate

Lisa Tuite

Kurt Dodd

Franz Wuerfmannsdobler

Ellen Doneski

John Richards

Office of Senator Byrd

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Office of Senator Byrd

Office of Senator Rockefeller

Office of Senator Rockefeller

Industry

Charles Goodman

John Wooten

Ben Yamagata

Southern Company

Peabody Group

Coal Utilization Research Council

DRAFT**Questions to answer -**

1. Does the Administration believe coal will remain an important component in both national and global energy supplies, providing that clean coal technologies (CCT) can be demonstrated?
2. Is the Administration willing to work with industry to develop the R&D and tax incentive proposals necessary to commercialize CCT that can also help the U.S. achieve its environmental objectives?
3. Is the Administration willing to support the long-term financial package necessary to direct the R&D requirements and overcome the current technical and economic barriers that can commercialize and improve CCT performance?
4. What incentives and proposals is the Administration willing to support in order to move CCT towards commercial demonstration both domestically and internationally?

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- 3. Is the Administration willing to support the long-term financial package necessary to direct the R&D requirements and overcome the current technical and economic barriers that can commercialize and improve CCT performance?**
- 4. What incentives and proposals is the Administration willing to support in order to move CCT towards commercial demonstration both domestically and internationally?**

CLIMATE CHANGE AND THE COAL SECTOR

Highlights of Administration's Efforts

1. Coal's Value in America's Energy Future

Coal plays an important role in the nation's energy portfolio. The Administration's National Energy Strategy makes clear the importance of maintaining a diverse energy supply -- including coal, which now fuels 54% of U.S. power generation. Equally important is the need to ensure that the environmental impacts of energy production are addressed -- meaning that in climate terms, we are committed to ensuring that the coal our nation consumes is used in the cleanest, most efficient way.

Our efforts to address climate change provide incentives to the private sector to be more energy-efficient and to produce products that are less greenhouse gas intensive. 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. In fact, our analysis of robust international emissions trading shows coal use growing by 2-3% above 1995 levels, although its share of total U.S. energy consumption declines as renewables, gas and efficiency technologies meet growth needs. Thus, the Administration expects coal to play a strong role in America's energy mix for many years to come.

2. Administration's Plans for Coal in Climate Mitigation.

The Administration supports policies that meet the nation's climate objectives while avoiding an undue burden on coal and coal mining communities. These efforts include both international and domestic initiatives.

International Policy Architecture

The Administration's international policy combines serious environmental targets with maximum economic flexibility. As described above, the flexibility measures included in the Kyoto Protocol -- a full suite of six major greenhouse gases, sinks, international emissions trading, joint implementation, the Clean Development Mechanism and multi-year emissions targets -- will all work to bring down domestic costs and consequently reduce the impact on coal. "Maximum flexibility" has been our priority for multiple reasons: it represents good environmental, science, energy and economic policy. For every dollar invested, our nation can achieve the maximum environmental gain in ways consistent with sound science and with minimal disruption of energy markets.

Department of Energy's Research, Development and Deployment Programs

R&D programs. The Administration recognizes that a solid research and development program is needed to develop even more advanced technologies for using the nation's abundant supply of coal. Our FY2000 budget proposes \$122 million for advanced coal technology programs that will help drive down costs and increase penetration of advanced technologies in the power sector. DOE's advanced coal program ("*Vision 21*") aims to double the current power generation efficiencies within the next 10 - 15 years while keeping electricity costs 10% - 20% below those of today's plants. We see particular promise -- growing out of the Clean Coal Technology program -- in "Integrated Gasification Combined Cycle" power generation and "Pressurized Fluidized Bed Combustion." DOE continues to develop improved components for these technologies.

Sequestration. DOE is also engaged in research and development on sequestration technologies that can absorb and hold waste carbon gases from coal combustion (e.g. in depleted oil and gas reserves or in the deep ocean). When combined with ultra-high efficiency coal burning techniques, proper sequestration could make coal benign in climate terms. Sequestration R&D at DOE is growing, with \$13 million in FY99 and \$29 million proposed for FY2000.

Industries of the Future: The Mining Industry. In 1998, the DOE Office of Industrial Technology launched a

“Industries of the Future” collaborative with mining companies. It is seeking to bring the entire industry together behind their leaders’ common vision of energy, economic and environmental improvements they seek by the year 2020. To achieve that vision, the industry will develop a technology roadmap that can be used to target public and private investment toward strategies to achieve their vision. This follows similar initiatives with aluminum, steel, forest products and others that have proven extremely valuable in improving R&D partnerships. These programs are slated for increased funding in the Climate Change Technology Initiative -- up from \$58 million in FY 99 to \$74.0 million in our FY2000 request.

Interior Department’s Plans for Increased Sequestration in Abandoned Mine Land Reclamation.

One promising area for improved carbon management relates to reforestation of mined lands to mitigate carbon. The Department of Interior’s Office of Surface Mining began in 1998 to focus more on carbon mitigation in the mined land reclamation programs. In essence, this could be accomplished by promoting techniques that enhance carbon uptake of trees planted on these sites. There are important employment and community development advantages to this approach, as the dollars spent and jobs created in reclamation work flow to directly into communities that have been heavily coal dependent, where the mining is completed and workers are unemployed. Coal and electric power companies support this program as an important vehicle for achieving low cost reductions through sinks.

The funding profile for this program is improving. OSM collects fees from mining companies totaling about \$300 million per year. Much to the consternation of industry, they only spend about \$200 million per year -- the rest used for budget offsets. In recent years, OSM received modest increases (about \$2 million in FY99). In the FY 2000 budget, the Administration proposed an increase of \$25 million with plans to ramp it up by \$25 million in each of the following 3 years so that it will be allowed to invest all that is collected.

Congressional Action on Credit for Early Action

The current Chafee-Mack-Lieberman bill to provide credit for early action could be another important way of providing incentives to business for low cost carbon mitigation. The President highlighted his support for passing bipartisan legislation in this regard as part of his State of the Union message. While we have not reached policy conclusions on the details of the legislation, we plan to engage seriously in the most constructive way possible. We want to work closely with the Senate to get a bill passed this Congress. We are also working closely with industry and environmental groups to ensure that this is a workable program with high environmental integrity.

3. Examining Coal-Related Tax Incentives

The Administration’s FY2000 tax proposal includes two primary provisions that could work to the benefit of the coal industry: an incentive for combined heat and power worth an estimated \$300 million over 3 years, and an incentive for coal biomass co-firing, biomass and wind energy worth an estimated \$300 million over 5 years.

The Administration has met with industry groups advocating tax incentives aimed at clean coal technology and advanced coking technologies. At this stage, we have not completed review and consultation on these proposals. We intend to continue the dialogue with coal groups, electric utilities, steel firms and labor organizations to explore these and other ideas.

4. Transition Assistance

The President has committed to provide transition assistance to workers or communities that may be adversely effected by climate mitigation efforts. The Administration is committed to work closely with labor groups and communities to explore ways that government can help in situations where there may be dislocations.

CLIMATE CHANGE AND THE COAL SECTOR

Highlights of Administration's Efforts

1. The current picture, recent trends and outlook.

As a policy matter, the Administration believes that coal plays an important role in the nation's energy portfolio. Our National Energy Strategy makes clear the importance of maintaining a diverse energy supply -- including coal, which now fuels 54% of U.S. power generation. Equally important is the need to ensure that the environmental impacts of energy production are addressed -- meaning that in climate terms, we are committed to ensuring that the coal our nation consumes is used in the cleanest, most efficient way.

Our efforts to address climate change are likely to provide incentives to the private sector to consume energy-efficient and less greenhouse gas intensive products. In terms of energy use, fossil fuels that produce relatively large amounts of carbon dioxide from combustion (such as coal) will become less economically attractive than fuels that produce lower amounts of greenhouse gases (such as natural gas and renewables). The necessity of shifting away from coal use has spurred some criticism that the Kyoto Protocol will result in significant job losses in the coal industry. We are convinced that some of these concerns are overly pessimistic, given our analysis of the trends in this industry and the likely employment effects portrayed in some of the existing modeling analyses.

Overview of the Coal Industry:

The coal industry has experienced substantial productivity gains over the past half-century. While coal prices climbed significantly during the energy crisis of the 1970s, prices in real terms have now declined to nearly the lowest levels experienced over the past 40 years, and are forecast to decline even further under business as usual projections through 2020.

Much of the decline in coal prices reflects improvements in productivity (measured by tons of coal produced per hour of labor). Since the decline in productivity of the mid-1970s, coal mining productivity has improved at an astounding 7% rate per year. Surface mining operations, which tend to be more prevalent in the west, have much higher absolute levels of productivity while underground mining operations have experienced slightly faster rates of productivity *growth* over the past 15 years. Surface coal miners were 2.6 times and underground miners were 2.8 times more productive in 1995 than they were in 1980.

While mining employment increased in response to increased demand for coal during the 1970s energy crisis, the last two decades have witnessed a steady decline in employment. Current mining employment is one-third of its peak in 1978 of 245,000. However, overall coal production has tended to increase as gains in productivity have outpaced the decline in employment. Since 1980, mining employment has declined at an average rate of 6.1% per year, while production has increased by an average of 1.6% per year. By 2010, coal mining employment under a continuation of current policies (the "business as usual" case) is projected to be about 62,000, reflecting an average 2.1% annual rate of decline between 1996 and 2010. Some have claimed that the faster average annual rate of decline (7.3%) in the 1990s reflects the effects of Clean Air Act rules, such as the limits on SO₂ emissions and the SO₂ trading program (which have spurred the development of lower-sulfur western surface coal at the expense of higher-sulfur eastern underground coal).

Overview of Modeling Analyses

The model used by the Administration to illustrate the economic effects of the Administration's climate change policies, the Second Generation Model, is a long-run economic model that assumes no aggregate

employment impacts (because the model assumes that the economy is in equilibrium, which implies that demand for labor exactly equals supply). Indeed, most of the models in the Stanford Energy Modeling Forum exercise and the OECD model comparison effort are similar long-run (general equilibrium) economic models that assume no aggregate employment impacts. While this is an appropriate assumption for small energy price increases over a long time horizon, it cannot provide information on short-term employment effects in any particular industry, such as the coal industry. However, short-run economic models, such as the macroeconomic model constructed by DRI, can provide information about industry-specific employment effects. While some have expressed concern about using these short-run models to evaluate time periods as long as 10 to 20 years, we provide two sets of results that describe the potential range of employment effects in the coal mining industry. These results are based on the same macroeconomic model, but incorporate different estimated permit prices --two lower ones from the Administration's analysis and a higher one from an analysis commissioned by the United Mine Workers.

The United Mine Workers commissioned a study using the DRI macroeconomic model to evaluate the economic effects of abating carbon dioxide emissions. This study analyzed three separate scenarios, but provided detailed results on only the middle scenario. This more detailed analysis assumes that 58 percent of the reductions from the "business as usual" projection necessary for the United States to meet its Kyoto Protocol target will be achieved from the domestic energy sector, generating an estimated 2010 permit price of \$113/ton of carbon equivalent. Alternatively, the Environmental Protection Agency used the DRI macroeconomic model to assess the economic effects associated with permit prices of \$14 and \$23/ton of carbon equivalent.

Coal Mining Industry	\$14/ton (EPA)	\$23/ton (EPA)	\$113/ton (UMW)
Employment Losses	3,470	6,750	28,740
Employment Losses (% below 2010 BAU)	5.1%	9.9%	36.1%
2010 BAU Employment Level	68,200	68,200	79,550

Note: EIA projects 2010 BAU employment in the coal mining industry to be 62,190.

As shown in the table, higher permit prices rise lead to larger employment loss in the coal sector. The employment losses with permit prices of \$14 to \$23/ton are projected to be in the range of 5 to 10% of BAU employment in the coal industry in 2010. It is interesting to note that the variation in estimates of BAU employment range from a low of 62,190 by EIA to a high of 79,550 by UMW, a range of 28%. Given the large variation in "business as usual" employment projections for 2010, employment changes projected in the 5-10 percent range could be considered small to negligible.

Minimizing Employment Losses

The models indicate that the key to minimizing coal mining industry dislocation is to limit the amount of emissions reductions that occur in the domestic energy sector, especially electricity generation. In general, this is consistent with achieving relatively low permit prices for meeting greenhouse gas abatement targets. International emissions trading can significantly reduce estimated greenhouse gas permit prices and the projected burden on the domestic energy sector. Moreover, opportunities to abate greenhouse gas emissions other than carbon dioxide and to promote sink activities can further minimize estimated permit prices and the likely effect on the domestic energy sector, including the coal mining industry.

2. Current efforts to mitigate impacts on coal.

We are working to promote policies and strategies that meet our climate objectives in ways that mitigate the impact on coal & coal mining communities. These efforts include both international and domestic initiatives.

International Policy Architecture

The Administration's international policy priorities combine serious environmental targets and maximum economic flexibility. As described above, the flexibility measures included in the Kyoto Protocol -- all six major greenhouse gases, sinks, international emissions trading, joint implementation, the Clean Development Mechanism and multi-year emissions targets -- all work to bring down domestic costs and consequently reduce the impact on coal. "Maximum flexibility" has been our priority for multiple reasons: good environmental and science policy as well as solid energy policy, because it helps reinforce our energy diversity goals.

DOE's Research, Development and Deployment Programs

R&D programs. Our climate-related energy efficiency programs include advanced coal technology programs that will help drive down costs and increase penetration of advanced technologies at power plants. DOE's Coal Power R&D program is focused through a strategy dubbed "*Vision 21*" on doubling the current power generation efficiencies within the next 10 - 15 years while keeping electricity costs 10% - 20% below those of today's plants. We see particular promise -- growing out of the Clean Coal Technology program -- in *Integrated Gasification Combined Cycle* and *Pressurized Fluidized Bed Combustion*, for which DOE continues to develop improved technological components.

The funding level for the DOE Coal and Power R&D Program for FY2000 is \$214M -- a level higher than rumored, in part due to recognition by the White House climate team of the importance of a solid r&d program to develop even more advanced technologies for using the nation's abundant supply of coal.

	<u>FY1998</u>		<u>FY1999</u>		<u>Final</u>
Generation Efficiency r&d	157.6		170.4		168.2
Fuels r&d	15.8	15.5		14.5	
Sequestration r&d	1.6	5.9		9.1	
Advanced research	17.6		19.9		23.2
Total	192.6	211.8			214.0

Sequestration. DOE is also engaged in research and development on sequestration technologies that can absorb and hold waste carbon gases from coal combustion. When combined with ultra-high efficiency coal burning techniques, these sequestration technologies could make coal benign in climate terms. Sequestration R&D at DOE is in its earliest stages. The first significant funding from Congress was approved in FY 1999 (\$6 million for applied research in the Office of Fossil Energy and \$13 million in more basic, exploratory research in the Office of Science).

The Administration has strong interest in future funding increases for sequestration r&d. The proposed FY2000 level for sequestration is a 54% increase over FY99, which represents a good ramp-up level.

Industries of the Future: The Mining Industry. In 1998, the DOE Office of Industrial Technology launched a "Industries of the Future" collaborative with mining companies. It is seeking to bring the entire industry together behind a CEO vision of energy, economic and environmental improvements they seek by the year 2020. To achieve that vision, the industry will develop a technology roadmap that can be used to help target public and private investment toward strategies to achieve their vision. This follows similar initiatives with aluminum, steel, forest products and others that have proven extremely valuable in improving R&D partnerships.

This program is slated for increased funding as part of the CCTI-- up from \$53 m. in FY 98(enacted), \$58 million in FY 99 (enacted) to \$74.0 m. in our FY2000 request.

Tax Incentives

While we are not prepared to discuss specifics of our tax package, we want you to know that we are working to improve the biomass provisions to permit more co-firing with coal. And we will likely change other provisions -- some to make substantive changes, some to keep the costs down. All of the improvements are made in response to valuable input from constituencies -- but they will not necessarily hit the mark perfectly for those groups. We have high hopes of advancing this in the legislative process this year.

Sequestration in abandoned mineland reclamation.

One promising area for improved carbon management relates to reforestation of mined lands that can be done to mitigate carbon -- perhaps even creating carbon emissions credits in an early action crediting regime.

The Department of Interior's Office of Surface Mining began about a year ago to focus mined land reclamation work more intensively on carbon mitigation. In essence, this could be accomplished by promoting techniques that maximize the carbon uptake of trees planted on these sites. There are important employment advantages to this approach, as the dollars spent and jobs created in the reclamation work flow to directly into communities that have been heavily coal dependent, where the mining is completed and workers are already unemployed. Electric power companies have advocated this program as an important vehicle for achieving low cost reductions through sinks.

The funding profile for this program is greatly improved. This office takes in fees from mining companies at a rate of about \$300 million per year, but much to the consternation of the industry, they only spend about \$200 million per year -- the rest used for budget offsets. In recent years, they got very modest increases-- in FY99, they got a \$2 million increase. In the FY 2000 budget, this program will get an increase of \$25 million (10 times last year's), and OMB plans on ramping it up \$25 million for the following 3 years so that it will be allowed to invest all that it raises.

Credit for Early Action

The current Chafee-Mack-Lieberman bill to provide credit for early action could be another important way of providing incentives to business for low cost carbon mitigation. The President highlighted his support for passing bipartisan legislation in this regard as part of his State of the Union message. While we have not reached policy conclusions on the details of the Chafee bill, we plan to engage seriously in the most constructive way possible -- which may involve keeping a low profile for a while. We are likely to testify in the Environment & Public Works Committee on the principles we would use to guide our policy development. We want to work closely with the Senate to get a bill passed this Congress. We are also working closely with industry (AEP & others) and NGO's to ensure that this is a workable program with high environmental credibility.

3. We recognize that we need to do even better and have launched a process to examine new policy initiatives that might help.

While the government's coal related activities may offer benefits that have not been well appreciated, we also know that there is more that could be done. In particular, we have met with industry groups advocating other improvements, notably tax incentives to spur adoption of clean coal technologies as well as tax provisions to support advanced coking technologies.

At this stage, we have not completed review and consultation on these items -- and our tax package could not accommodate increases of the magnitude contemplated in those proposals -- we want to continue the dialogue with coal groups, electric utilities, steel firms and labor in hopes of finding common ground, should we find ourselves in a posture where more money was available in a tax bill.

4. International Issues

China. We know there is tremendous potential for clean coal technology development in China. We are evaluating some potential strategies that we may want to discuss further as the year proceeds. The President raised the climate issue in his trip to China -- as Sen. Byrd suggested -- and we will continue to use every diplomatic means to engage China constructively on this issue.

Senate. We've read of some possible legislative efforts that Sen. Hagel is considering. Though we do not know specifics, we would like to work closely with you if this interest materializes.

As a policy matter, the Administration believes that coal plays an important role in the nation's energy portfolio. Our National Energy Strategy makes clear the importance of maintaining a diverse energy supply. The challenge of global climate change calls for the development of less carbon-intensive energy producing technologies and the increased use of energy efficient technologies.

Administration policy on the Kyoto Protocol, which would limit annual U.S. greenhouse gas emissions to 7% below 1990 levels for the period 2008-2012, is to rely on flexibility mechanisms such as international trading of CO₂ emission credits to keep the cost of compliance to the economy low. Current models by the Council of Economic Advisors indicate that this is possible – with a predicted credit price of \$14-\$23/ton of Ce.

These models also indicate a continued reliance on the use of coal for generating electricity. While the fraction of electricity generated from coal will decline because of growth, the amount of coal used during the compliance period of 2008-2012 is expected to be 2-3% higher than in 1995 – or about the same as current levels. Because coal is so important to our nation's energy future, it figures prominently in the Administrations FY2000 budget request.

- \$122 million for R&D to develop next-generation technologies for coal combustion with much higher energy efficiency and lower greenhouse gas emissions.
- \$9.1 million for research into technology for carbon sequestration (54% >1999).

In addition, the Administration's Climate Change Technology Initiative includes a tax credit for coal/biomass co-firing to reduce CO₂ emissions while continuing to utilize coal.

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 10% of the total project cost,
- (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.

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

November 1998

Clinton Presidential Records Digital Records Marker

This is not a presidential record. This is used as an administrative marker by the William J. Clinton Presidential Library Staff.

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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 10% of the total project cost.

(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	1.15
	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

*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

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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 10% of the total project cost.

(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	1.15
	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

*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 \$937 million (1998\$). The total cost of the program over its 22 years life would be \$1,896 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)				
	2000-2004	2005-2009	2010-2014	2000-2021
Investment Tax Credit	\$180	\$145	\$81	\$406
Production Tax Credit	\$59	\$383	\$485	\$1,214
Risk Pool Appropriation	\$34	\$136	\$107	\$276
Total	\$273	\$664	\$673	\$1,896

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.

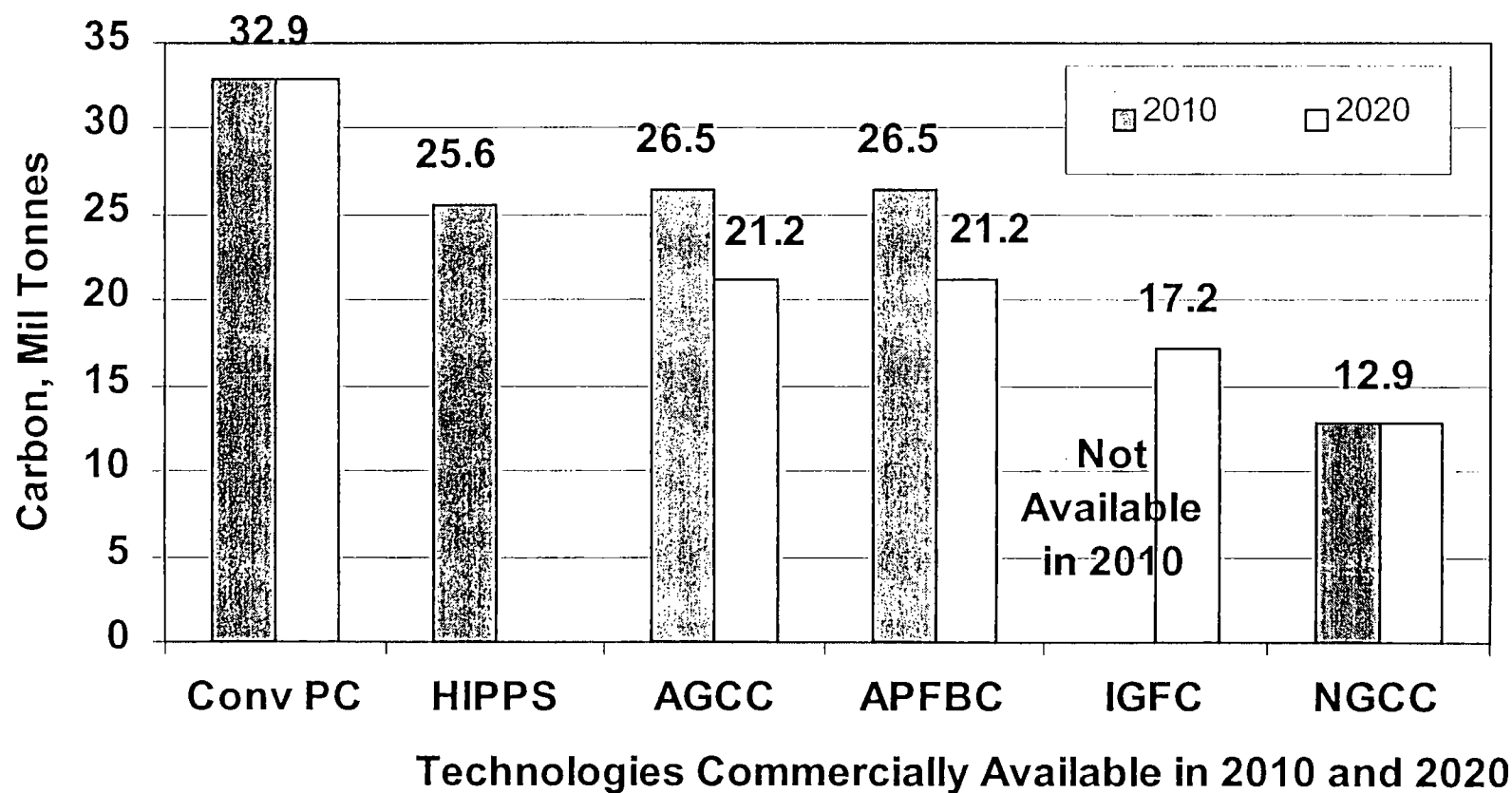
Budget Implications for the Incentives and R&D Program for the Early Commercial Applications of Clean Coal Technology:

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.

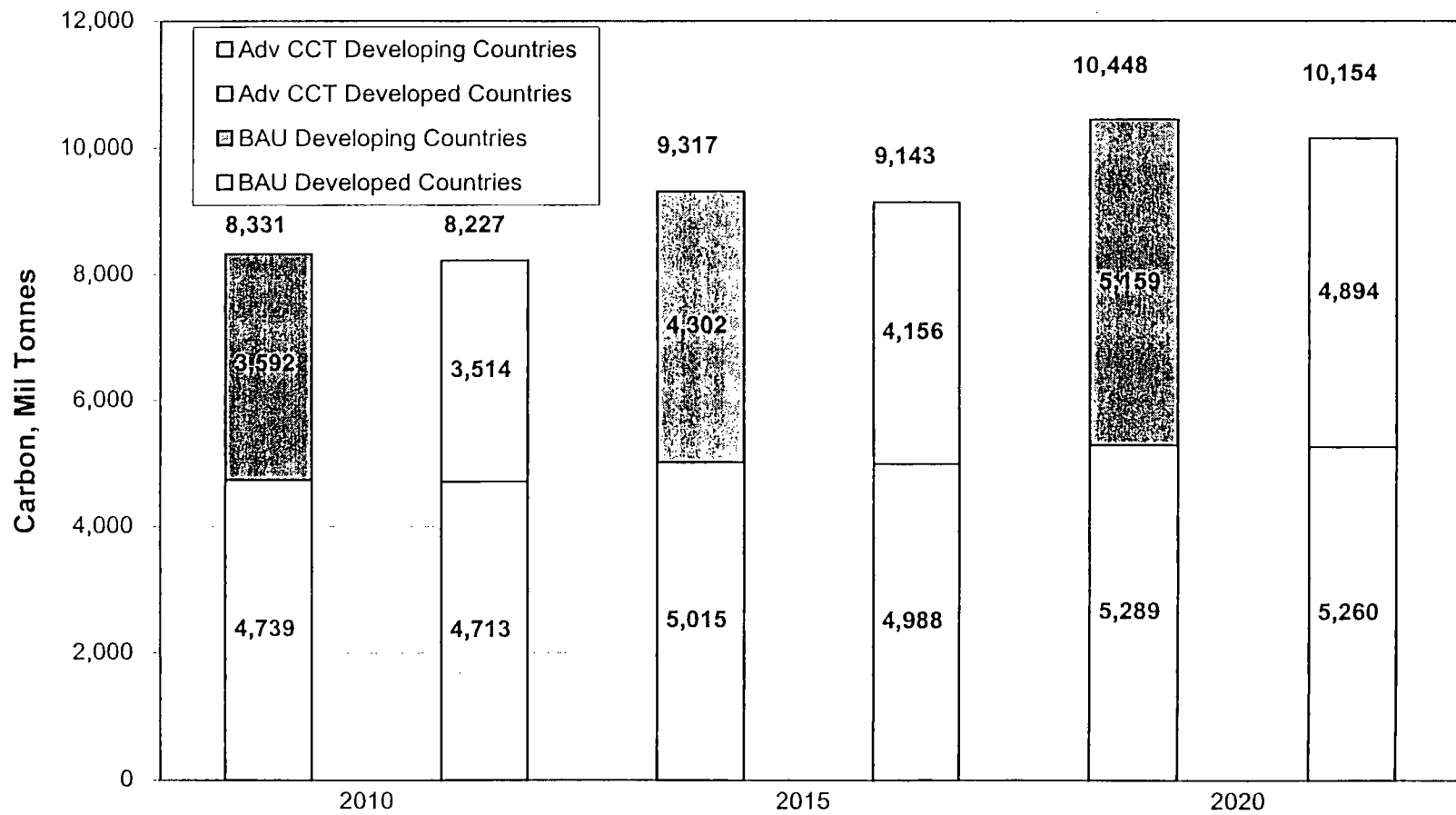
The DOE should develop its budget for fossil R&D in terms of the elements and timeframes shown in attachment B so that a common baseline is established for the CCT program. DOE should recast and explain its current program/budget and schedule within the appropriate timeframes so that recommendations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

Life Cycle Carbon Emissions From Clean Coal Technologies



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						
Capacity, MW					Advanced	Hybrid
Capacity Factor				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						
Capacity, MW					Advanced	Hybrid
Capacity Factor				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

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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																						1/28/99
				1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2021	
Tax Revenue Impacts, \$x000																						
		Installed Capacity MW	Installed Cost \$/KW																			
Technology																						
Adv PCF																						
Investment Tax Credit			500	1,150					\$74,670													
Production Tax Credit										\$22,995	\$23,816	\$24,638	\$24,638	\$24,638	\$19,710	\$19,710	\$19,710	\$19,710	\$19,710			
Investment Tax Credit			500	1,095									\$76,960									
Production Tax Credit														\$27,594	\$28,580	\$29,565	\$29,565	\$29,565	\$26,280	\$26,280		
PFBC																						
Investment Tax Credit			500	1,250					\$81,163													
Production Tax Credit										\$26,280	\$28,470	\$30,660	\$32,850	\$32,850	\$26,280	\$26,280	\$26,280	\$26,280	\$26,280			
Investment Tax Credit			500	1,190									\$83,637									
Production Tax Credit														\$30,222	\$32,741	\$35,259	\$37,778	\$37,778	\$29,565	\$29,565		
Investment Tax Credit			500	1,130													\$85,967					
Production Tax Credit																		\$35,478	\$38,435	\$41,391	\$37,778	
IGCC																						
Investment Tax Credit			500	1,300					\$84,410													
Production Tax Credit										\$34,164	\$37,011	\$39,858	\$42,705	\$42,705	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778			
Investment Tax Credit			500	1,205									\$84,691									
Production Tax Credit														\$35,478	\$38,435	\$41,391	\$44,348	\$44,348	\$36,135	\$36,135		
Investment Tax Credit			500	1,145													\$87,108					
Production Tax Credit																		\$40,734	\$44,129	\$47,523	\$44,348	
Total Revenue Impact																						
Investment Tax Credit			4,000	1,183					\$240,243	\$0	\$0	\$0	\$245,288	\$0	\$0	\$0	\$173,074					
Production Tax Credit										\$83,439	\$89,297	\$95,156	\$100,193	\$193,487	\$183,522	\$189,983	\$195,458	\$271,670	\$258,311	\$180,894	\$82,125	
Total									\$240,243	\$83,439	\$89,297	\$95,156	\$345,480	\$193,487	\$183,522	\$189,983	\$368,532	\$271,670	\$258,311	\$180,894	\$82,125	
Total Revenue Impact (1998\$, Discounted @ T-Bill rate of 6%)																						
Investment Tax Credit									\$179,524	\$0	\$0	\$0	\$145,185	\$0	\$0	\$0	\$81,144	\$0	\$0	\$0	\$0	
Production Tax Credit									\$0	\$58,821	\$59,388	\$59,702	\$59,304	\$108,042	\$96,677	\$94,415	\$91,638	\$120,160	\$107,784	\$71,208	\$21,500	
Total									\$179,524	\$58,821	\$59,388	\$59,702	\$204,489	\$108,042	\$96,677	\$94,415	\$172,782	\$120,160	\$107,784	\$71,208	\$21,500	
Total Revenue 2000-2004 (1998\$)										\$238,345												
Total Revenue 2005-2009 (1998\$)															\$528,298							
Total Revenue 2000-2021 (1998\$)																					\$1,619,727	

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

Tax Revenue, Appropriations and Environmental Impacts - Electricity Production																						1/28/99
					1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	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 2000-2004(1998\$)											\$33,619											
Total 2005-2009(1998\$)																\$135,887						
Total 2000-2021(1998\$)																					\$276,489	
Carbon Equivalents Reductions (100 Year Warming Potential), Tonnes																						
		Heat Rate	Thermal																			
Technology		Btu/kWh	Efficiency																			
Conventional PCF		9,300	37%																			
Adv PCF		8,750	39%								46,506	46,506	46,506	46,506	46,506	46,506	46,506	46,506	46,506	46,506	46,506	
		8,315	41%												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	
		8,125	42%												99,353	99,353	99,353	99,353	99,353	99,353	99,353	
		7,720	44%																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	
		7,770	44%												129,371	129,371	129,371	129,371	129,371	129,371	129,371	
		7,380	46%																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	
2000-2004										0												
2005-2009															1,242,126							
2000-2021															109						10,676,028	
																					178	

Page A-3

Page A-4

Page A-5

Integrated Gasification Combined Cycle 500MW Plant (2004)																	1/28/99
capacity			500	MW		capital carrying charges		13.50%		Investment tax credit		10.0%	of total investment				
heat rate			8400	Btu/kWh		depreciation		Straight Line		Production tax credit							
fuel cost			\$1.20	/mmBtu		initial cost		\$1,300 /kW		1st 5 years of operation		\$13.00	per megawatt hour				
fuel escalation			1.5%			% debt financing		75%		2nd five years of operation		\$11.50	per megawatt hour				
inflation			2.0%			cost of debt		10%		Risk Pool		5.0%	of capital investment, years 1-3				
non-fuel variable O&M			2.25	\$/MWh		cost of equity		18%									
fixed O&M			25	\$/kW-yr		weighted ave cost of capital		9%									
capacity factor, years 4-20			75%			G&A		2%			Year 1	Year 2	Year 3				
generation, years 4-20			3,285,000	MWh		tax rate		34%		Capacity factor	60.0%	65.0%	70.0%				
book life			20	years		construction expenditure cycle				Generation, MWh	2,628,000	2,847,000	3,066,000				
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									
initial cost			\$650,000	\$206,936	\$281,432	\$215,296	\$844,098	1	2	3	4	5	6	7	8	9	10
Revenue																	
electricity price, \$/MWh			\$36.73					\$41.36	\$42.19	\$43.03	\$43.89	\$44.77	\$45.66	\$46.58	\$47.51	\$48.46	\$49.43
electricity revenue								\$108,690	\$120,102	\$131,927	\$144,178	\$147,061	\$150,003	\$153,003	\$156,063	\$159,184	\$162,368
Expenses																	
fuel expense								\$28,966	\$31,850	\$34,815	\$37,861	\$38,429	\$39,005	\$39,590	\$40,184	\$40,787	\$41,399
non-fuel O&M								\$6,659	\$7,358	\$8,083	\$8,833	\$9,010	\$9,190	\$9,374	\$9,561	\$9,753	\$9,948
fixed O&M								\$14,077	\$14,359	\$14,646	\$14,939	\$15,237	\$15,542	\$15,853	\$16,170	\$16,493	\$16,823
total annual production expenses								\$49,702	\$53,567	\$57,543	\$61,833	\$62,676	\$63,737	\$64,817	\$65,916	\$67,033	\$68,170
electricity production expense, \$/MWh								\$18.91	\$18.82	\$18.77	\$18.76	\$19.08	\$19.40	\$19.73	\$20.07	\$20.41	\$20.75
depreciation (investment -ITC)20								\$37,984	\$37,984	\$37,984	\$37,984	\$37,984	\$37,984	\$37,984	\$37,984	\$37,984	\$37,984
G&A								\$16,882	\$16,882	\$16,882	\$16,882	\$16,882	\$16,882	\$16,882	\$16,882	\$16,882	\$16,882
total expenses								\$104,568	\$108,433	\$112,409	\$116,499	\$117,542	\$118,604	\$119,684	\$120,782	\$121,899	\$123,036
Net Income Before Taxes								\$4,122	\$11,669	\$19,518	\$27,679	\$29,519	\$31,399	\$33,319	\$35,281	\$37,285	\$39,332
taxes								\$1,401	\$3,967	\$6,636	\$9,411	\$10,036	\$10,676	\$11,329	\$11,995	\$12,677	\$13,373
Net Income after Taxes								\$2,720	\$7,701	\$12,882	\$18,268	\$19,483	\$20,723	\$21,991	\$23,285	\$24,608	\$25,959
Investment tax credit								\$84,410									
Production tax credit								\$34,164	\$37,011	\$39,858	\$42,705	\$42,705	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778
cash flow= NI + depreciation							(\$759,688)	\$74,869	\$82,697	\$90,724	\$98,957	\$100,172	\$96,485	\$97,753	\$99,047	\$100,370	\$101,721
IRR			9.50%														
PV Investment			(\$688,073)														
PV NI + depreciation @ WACC			\$690,351														
Risk pool appropriation								\$14,068	\$14,068	\$14,068							

Advanced Pulverized Coal-Fired 500 MW Plant (2008)																	1/28/99
capacity	500	MW	capital carrying charges	13.50%	Investment tax credit	10.0%	of total investment										
heat rate	8315	Btu/kWh	depreciation	Straight Line	Production tax credit												
fuel cost	\$1.20	/mmBtu	initial cost	\$1,095 /kW	1st 5 years of operation	\$9.00	per megawatt hour										
fuel escalation	1.5%		% debt financing	75%	2nd five years of operation	\$8.00	per megawatt hour										
inflation	2.0%		cost of debt	10%	Risk Pool	5.0%	of capital investment, years 1-3										
non-fuel variable O&M	2.25	\$/MWh	cost of equity	18%													
fixed O&M	25	\$/kW-yr	weighted ave cost of capital	9%													
capacity factor	75%		G&A	2%													
generation	3,285,000	MWh	tax rate	34%	Capacity factor	70.0%	Year 1	Year 2	Year 3								
book life	20	years	construction expenditure cycle		Generation, MWh	3,066,000	3,175,500	3,285,000									
useful life	30	years	year	1	30%												
loan term	20	years	year	2	40%												
T Bill Rate	6.0%		year	3	30%												
year	1998	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10		
initial cost	\$547,500	\$188,672	\$256,593	\$196,294	\$769,599												
Revenue																	
electricity price, \$/MWh	\$36.78					\$41.42	\$42.25	\$43.09	\$43.96	\$44.83	\$45.73	\$46.65	\$47.58	\$48.53	\$49.50		
electricity revenue						\$126,994	\$134,161	\$141,563	\$144,394	\$147,282	\$150,227	\$153,232	\$156,297	\$159,422	\$162,611		
Expenses																	
fuel expense						\$33,451	\$35,166	\$36,924	\$39,777	\$40,374	\$40,980	\$41,594	\$42,218	\$42,852	\$43,494		
non-fuel O&M						\$7,769	\$8,207	\$8,660	\$9,561	\$9,753	\$9,948	\$10,147	\$10,350	\$10,557	\$10,768		
fixed O&M						\$14,077	\$14,359	\$14,646	\$16,170	\$16,493	\$16,823	\$17,160	\$17,503	\$17,853	\$18,210		
total annual production expenses						\$55,297	\$57,731	\$60,230	\$65,509	\$66,620	\$67,751	\$68,901	\$70,071	\$71,261	\$72,472		
electricity production expense, \$/MWh						\$18.04	\$18.18	\$18.33	\$19.94	\$20.28	\$20.62	\$20.97	\$21.33	\$21.69	\$22.06		
depreciation (investment -ITC)/20						\$34,632	\$34,632	\$34,632	\$34,632	\$34,632	\$34,632	\$34,632	\$34,632	\$34,632	\$34,632		
G&A						\$15,392	\$15,392	\$15,392	\$15,392	\$15,392	\$15,392	\$15,392	\$15,392	\$15,392	\$15,392		
total expenses						\$105,321	\$107,755	\$110,254	\$115,533	\$116,644	\$117,775	\$118,925	\$120,095	\$121,285	\$122,496		
Net Income Before Taxes						\$21,674	\$26,405	\$31,309	\$28,861	\$30,638	\$32,453	\$34,307	\$36,202	\$38,137	\$40,115		
taxes						\$7,369	\$8,978	\$10,645	\$9,813	\$10,417	\$11,034	\$11,664	\$12,309	\$12,967	\$13,639		
Net Income after Taxes						\$14,305	\$17,428	\$20,664	\$19,048	\$20,221	\$21,419	\$22,643	\$23,893	\$25,171	\$26,476		
Investment tax credit						\$76,960											
Production tax credit						\$27,594	\$28,580	\$29,565	\$29,565	\$29,565	\$26,280	\$26,280	\$26,280	\$26,280	\$26,280		
cash flow= NI + depreciation						(\$692,639)	\$76,530	\$80,639	\$84,861	\$83,245	\$84,418	\$82,331	\$83,555	\$84,805	\$86,083		
IRR	9.48%																
PV Investment	(\$579,569)																
PV NI + depreciation @ WACC	\$580,607																
Risk pool appropriation						\$12,827	\$12,827	\$12,827									

Pressurized Fluidized Bed Combustion 500 MW Plant (2008)																	1/28/09
capacity	500	MW	capital carrying charges	13.50%	Investment tax credit	10.0%	of total investment										
heat rate	8125	Btu/kWh	depreciation	Straight Line	Production tax credit												
fuel cost	\$1.20	/mmBtu	initial cost	\$1,190 /kW	1st 5 years of operation	\$11.50	per megawatt hour										
fuel escalation	1.5%		% debt financing	75%	2nd five years of operation	\$9.00	per megawatt hour										
inflation	2.0%		cost of debt	10%	Risk Pool	5.0%	of capital investment, years 1-3										
non-fuel variable O&M	2.5	\$/MWh	cost of equity	18%													
fixed O&M	14	\$/kW-yr	weighted ave cost of capital	9%													
capacity factor, years 4-20	75%		G&A	2%													
generation, years 4-20	3,285,000	MWh	tax rate	34%	Capacity factor	60.0%	Year 1	65.0%	Year 2	70.0%	Year 3						
book life	20	years	construction expenditure cycle		Generation, MWh	2,628,000	2,847,000	3,066,000									
useful life	30	years	year	1	30%												
loan term	20	years	year	2	40%												
T Bill Rate	6.0%		year	3	30%												
year			1998	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
initial cost			\$595,000	\$205,040	\$278,855	\$213,324	\$836,367										
Revenue																	
electricity price, \$/MWh			\$36.78					\$41.42	\$42.25	\$43.09	\$43.96	\$44.83	\$45.73	\$46.65	\$47.58	\$48.53	\$49.50
electricity revenue								\$108,852	\$120,282	\$132,125	\$144,394	\$147,282	\$150,227	\$153,232	\$156,297	\$159,422	\$162,611
Expenses																	
fuel expense								\$28,017	\$30,807	\$33,675	\$38,869	\$39,452	\$40,043	\$40,644	\$41,254	\$41,872	\$42,501
non-fuel O&M								\$7,399	\$8,176	\$8,981	\$10,624	\$10,836	\$11,053	\$11,274	\$11,499	\$11,729	\$11,964
fixed O&M								\$7,883	\$8,041	\$8,202	\$9,055	\$9,236	\$9,421	\$9,609	\$9,802	\$9,998	\$10,198
total annual production expenses								\$43,299	\$47,024	\$50,857	\$58,548	\$59,524	\$60,517	\$61,528	\$62,555	\$63,600	\$64,662
electricity production expense, \$/MWh								\$16.48	\$16.52	\$16.59	\$17.82	\$18.12	\$18.42	\$18.73	\$19.04	\$19.36	\$19.68
depreciation (investment -ITCY/20								\$37,637	\$37,637	\$37,637	\$37,637	\$37,637	\$37,637	\$37,637	\$37,637	\$37,637	\$37,637
G&A								\$16,727	\$16,727	\$16,727	\$16,727	\$16,727	\$16,727	\$16,727	\$16,727	\$16,727	\$16,727
total expenses								\$97,663	\$101,388	\$105,221	\$112,911	\$113,888	\$114,881	\$115,891	\$116,919	\$117,964	\$119,026
Net Income Before Taxes								\$11,189	\$18,894	\$26,904	\$31,482	\$33,394	\$35,346	\$37,340	\$39,378	\$41,459	\$43,585
taxes								\$3,804	\$6,424	\$9,147	\$10,704	\$11,354	\$12,018	\$12,696	\$13,388	\$14,096	\$14,819
Net Income after Taxes								\$7,385	\$12,470	\$17,757	\$20,778	\$22,040	\$23,328	\$24,645	\$25,989	\$27,363	\$28,766
Investment tax credit								\$83,637									
Production tax credit								\$30,222	\$32,741	\$35,259	\$37,778	\$37,778	\$29,565	\$29,565	\$29,565	\$29,565	\$29,565
cash flow= NI + depreciation								(\$752,731)	\$75,243	\$82,847	\$90,652	\$96,192	\$97,454	\$90,530	\$91,846	\$93,191	\$94,564
IRR			9.43%														
PV Investment			(\$629,851)														
PV NI + depreciation @ WACC			\$628,872														
Risk pool appropriation								\$13,939	\$13,939	\$13,939							

NGCC 500 MW Plant (2012)																	1/28/99
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	-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	\$36.15					\$47.70	\$48.66	\$49.63	\$50.62	\$51.64	\$52.67	\$53.72	\$54.80	\$55.89	\$57.01		
revenue						\$156,706	\$159,840	\$163,037	\$166,297	\$169,623	\$173,016	\$176,476	\$180,006	\$183,606	\$187,278		
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						\$35,834	\$36,283	\$36,717	\$37,133	\$37,532	\$37,912	\$38,271	\$38,609	\$38,924	\$39,215		
taxes						\$12,183	\$12,336	\$12,484	\$12,625	\$12,761	\$12,890	\$13,012	\$13,127	\$13,234	\$13,333		
Net Income after Taxes						\$23,650	\$23,947	\$24,233	\$24,508	\$24,771	\$25,022	\$25,259	\$25,482	\$25,690	\$25,882		
cash flow= NI + depreciation																	
IRR	9.45%					(\$399,402)	\$43,620	\$43,917	\$44,203	\$44,478	\$44,741	\$44,992	\$45,229	\$45,452	\$45,660	\$45,852	
PV Investment																	
PV NI + depreciation																	

Pressurized Fluidized Bed Combustion 500 MW Plant (2012)																	1/28/99
capacity	500	MW	capital carrying charges	13.50%	Investment tax credit	10.0%	of total investment										
heat rate	7720	Btu/kWh	depreciation	Straight Line	Production tax credit												
fuel cost	\$1.20	/mmBtu	initial cost	\$1,130 /kW	1st 5 years of operation	\$13.50	per megawatt hour										
fuel escalation	1.5%		% debt financing	75%	2nd five years of operation	\$11.50	per megawatt hour										
inflation	2.0%		cost of debt	10%	Risk Pool	5.0%	of capital investment, years 1-3										
non-fuel variable O&M	2.5	\$/MWh	cost of equity	18%													
fixed O&M	14	\$/kW-yr	weighted ave cost of capital	9%													
capacity factor, years 4-20	75%		G&A	2%													
generation, years 4-20	3,285,000	MWh	tax rate	34%	Capacity factor	60.0%	Year 1	Year 2	Year 3								
book life	20	years	construction expenditure cycle		Generation, MWh	2,628,000	2,847,000	3,066,000									
useful life	30	years	year	1													
loan term	20	years	year	2													
T Bill Rate	6.0%		year	3													
year	1998	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10		
initial cost	\$565,000	\$210,752	\$286,623	\$219,266	\$859,665												
Revenue																	
electricity price, \$/MWh	\$36.15					\$40.71	\$41.53	\$42.36	\$43.21	\$44.07	\$44.95	\$45.85	\$46.77	\$47.70	\$48.66		
electricity revenue						\$106,998	\$118,232	\$129,874	\$141,933	\$144,772	\$147,667	\$150,621	\$153,633	\$156,706	\$159,840		
Expenses																	
fuel expense						\$26,621	\$29,272	\$31,996	\$39,197	\$39,785	\$40,382	\$40,988	\$41,603	\$42,227	\$42,860		
non-fuel O&M						\$7,399	\$8,176	\$8,981	\$11,499	\$11,729	\$11,964	\$12,203	\$12,447	\$12,696	\$12,950		
fixed O&M						\$7,883	\$8,041	\$8,202	\$9,802	\$9,998	\$10,198	\$10,402	\$10,610	\$10,822	\$11,038		
total annual production expenses						\$41,903	\$45,488	\$49,179	\$60,499	\$61,513	\$62,544	\$63,593	\$64,660	\$65,745	\$66,849		
electricity production expense, \$/MWh						\$15.94	\$15.98	\$16.04	\$18.42	\$18.73	\$19.04	\$19.36	\$19.68	\$20.01	\$20.35		
depreciation (investment -ITCY20						\$38,685	\$38,685	\$38,685	\$38,685	\$38,685	\$38,685	\$38,685	\$38,685	\$38,685	\$38,685		
G&A						\$17,193	\$17,193	\$17,193	\$17,193	\$17,193	\$17,193	\$17,193	\$17,193	\$17,193	\$17,193		
total expenses						\$97,781	\$101,367	\$105,057	\$116,377	\$117,391	\$118,422	\$119,471	\$120,538	\$121,623	\$122,727		
Net Income Before Taxes						\$9,217	\$16,866	\$24,817	\$25,557	\$27,381	\$29,245	\$31,150	\$33,095	\$35,083	\$37,113		
taxes						\$3,134	\$5,734	\$8,438	\$8,689	\$9,310	\$9,943	\$10,591	\$11,252	\$11,928	\$12,618		
Net Income after Taxes						\$6,083	\$11,131	\$16,379	\$16,867	\$18,072	\$19,302	\$20,559	\$21,843	\$23,155	\$24,495		
Investment tax credit						\$85,967											
Production tax credit						\$35,478	\$38,435	\$41,391	\$44,348	\$44,348	\$37,778	\$37,778	\$37,778	\$37,778	\$37,778		
cash flow= NI + depreciation						(\$773,699)	\$80,246	\$88,251	\$96,455	\$99,900	\$101,104	\$95,764	\$97,021	\$98,305	\$99,617	\$100,957	
IRR	9.45%																
PV Investment	(\$598,094)																
PV NI + depreciation @ WACC	\$597,920																
Risk pool appropriation						\$14,328	\$14,328	\$14,328									

Page A-13

Clinton Presidential Records Digital Records Marker

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R & D ROAD MAPS

Divider Title: _____

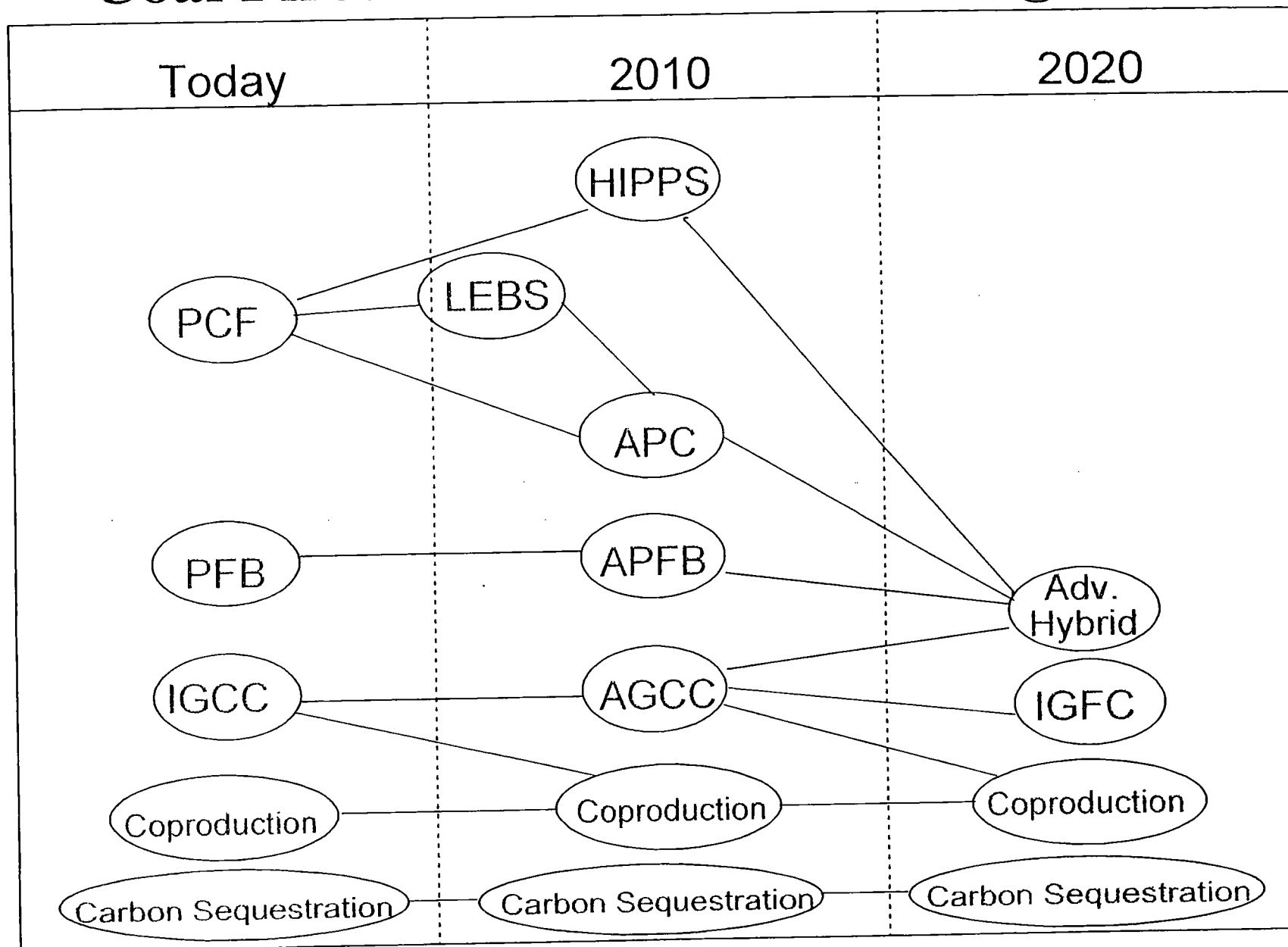
Attachment B

Research and Development Road Maps for Clean Coal Technologies

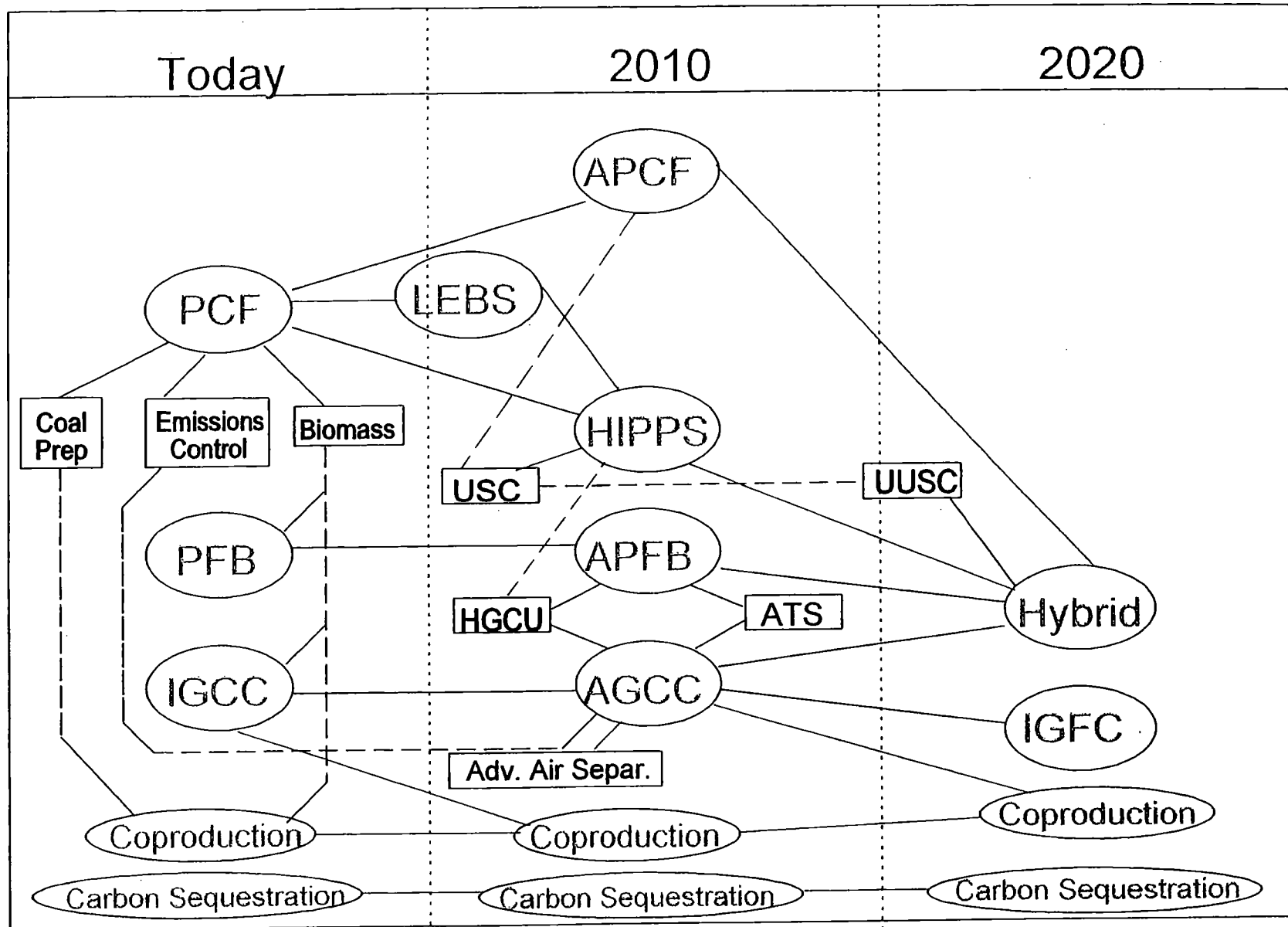
Performance Targets for Coal Generation

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

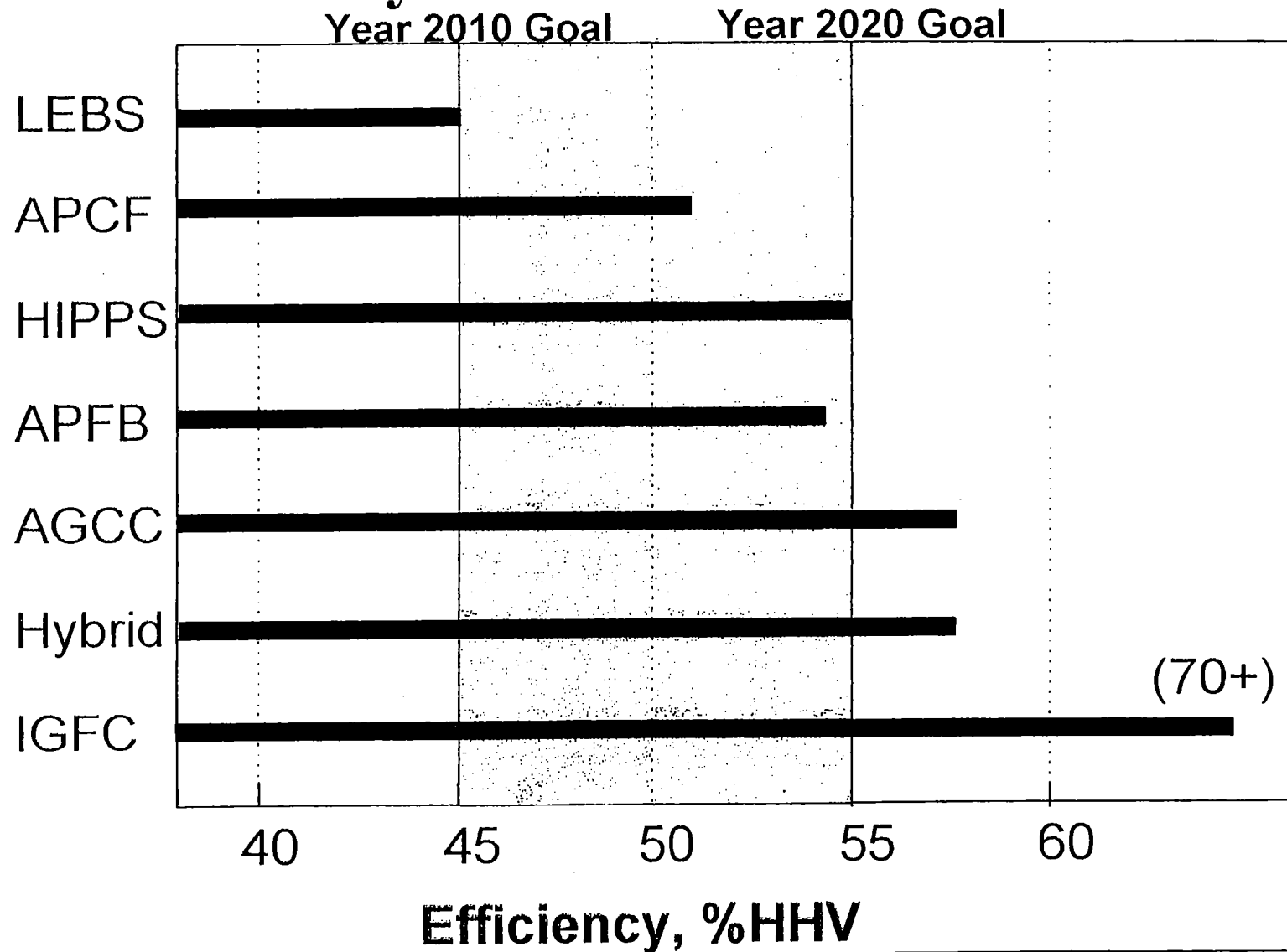


Coal Fired Power Plants / Enabling Technologies

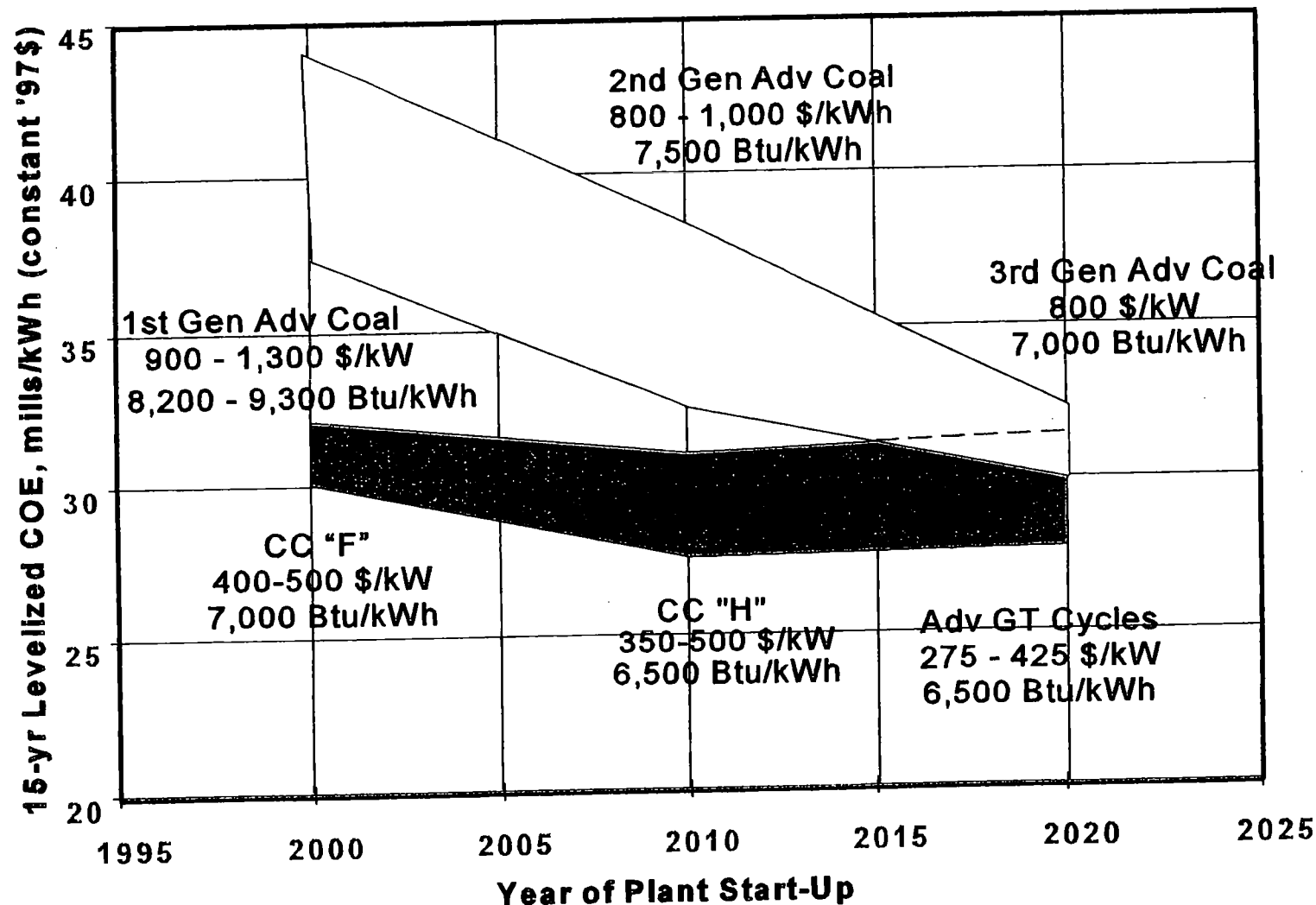


Enabling technologies to build industry core competencies include materials and lifting; sensors and controls; computational fluid dynamics; coal characterization; and coal preparation.

Efficiency Goals for Coal Fired Plants

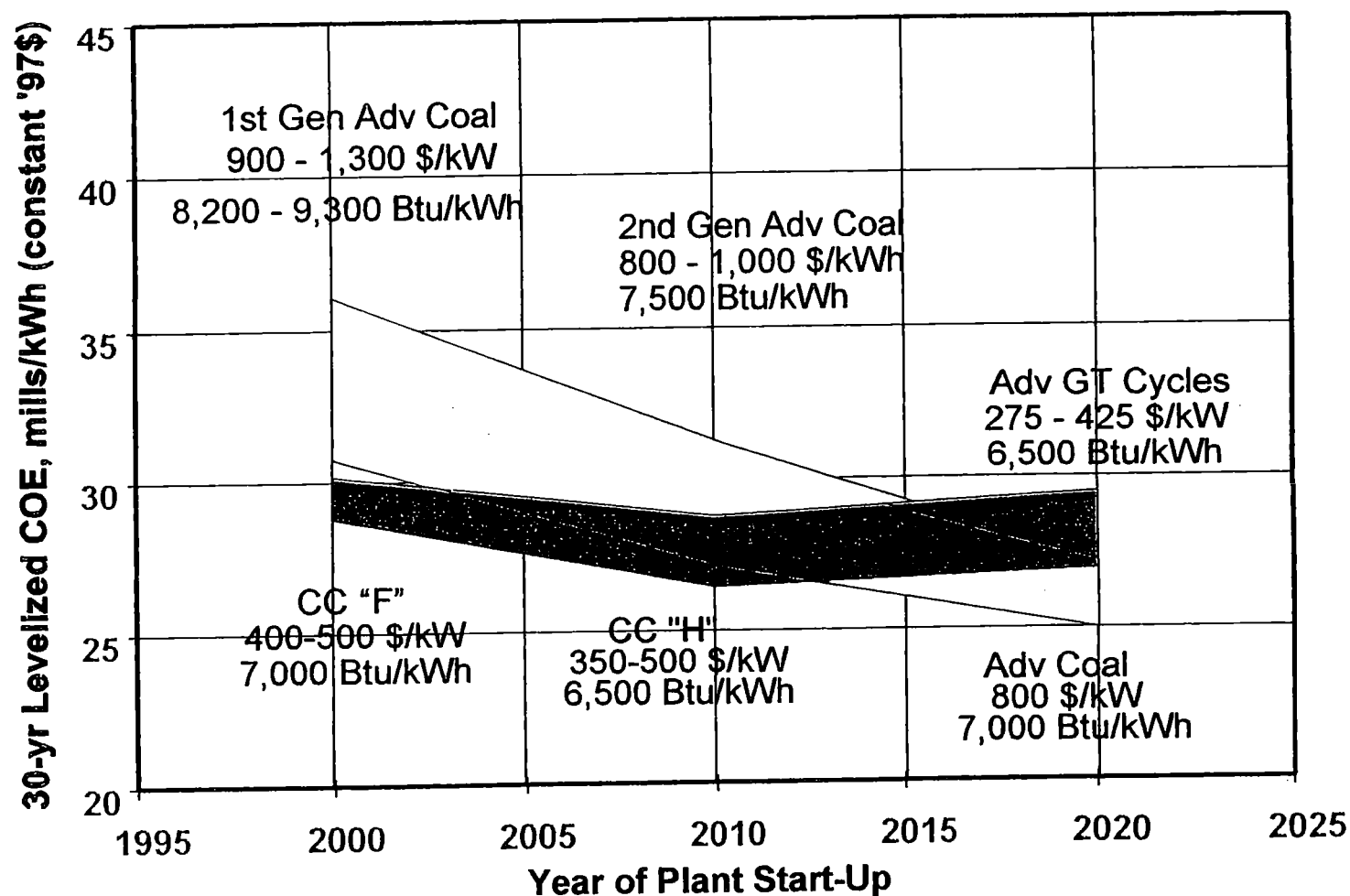


15-Year Levelized Cost of Electricity for Coal Fired v. Gas Fired Power Technologies



February 25, 1998

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	O2	Air or O2 with advanced air separation	Air or O2 with advanced air separation
SO2 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

February 25, 1998

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+
SO2 removal, %	n/a	n/a	99+
NOx, 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

February 25, 1998

HIPPS Performance Targets

Performance Target	Today	2010	2020
Capital Cost, \$/kW	n/a	800	800
Efficiency, %HHV	n/a	47	55
SO2 removal, %	n/a	99	99
NOx, 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

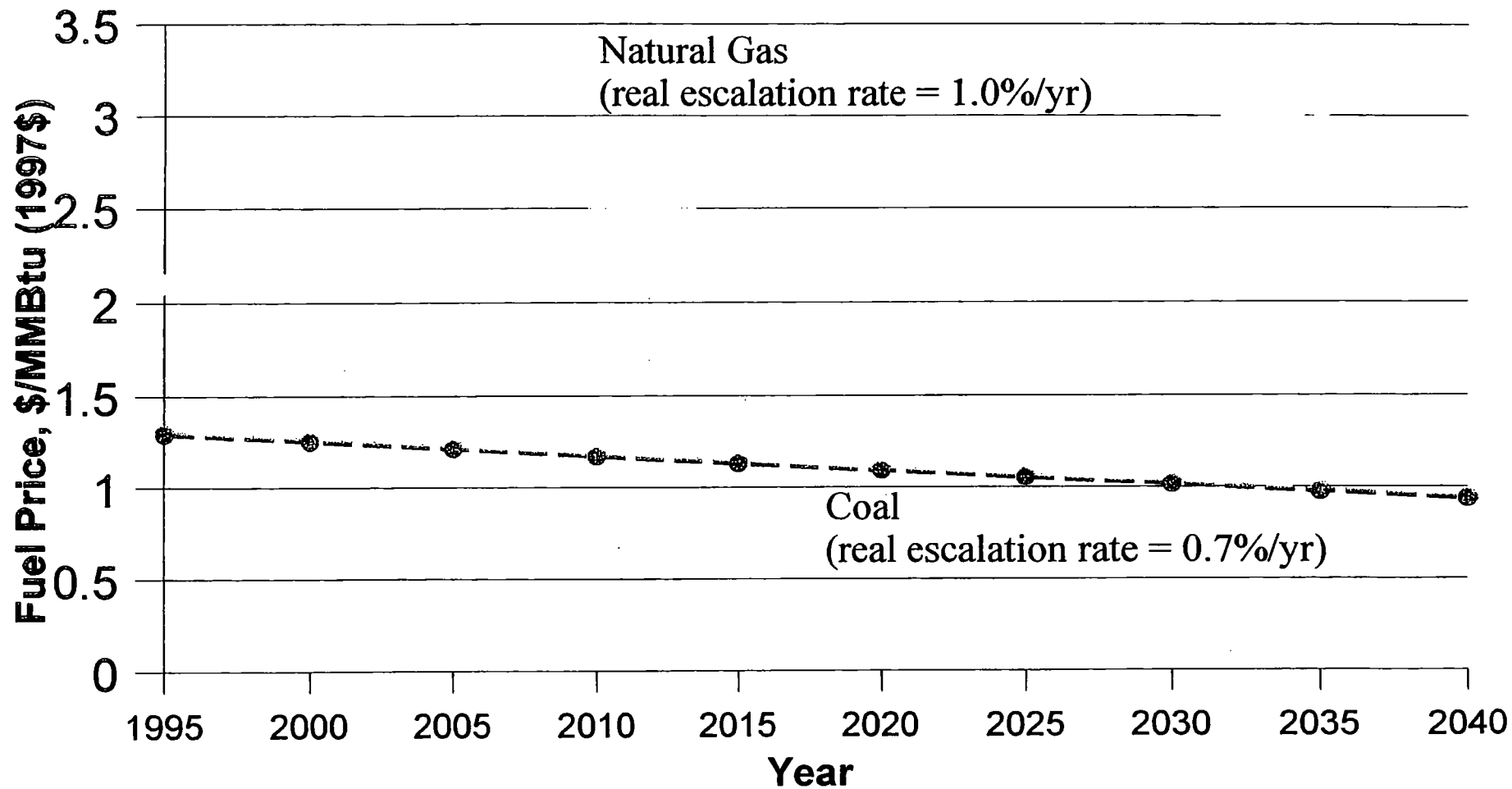
Crosscutting Enabling Technology

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
Note: Total Plant Costs are typical values. They vary depending on plant size and design, plant location, etc.								
Fuel Costs are based on EIA's 1997 AEO Projections (National Average)								

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