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the turbine combustor, effectively diluting the fuel to reduce NOx emissions. Saturating the syngas and the addition of saturated nitrogen also increases the mass flow to the gas turbine, resulting in increased electrical power generation.

Exhaust gas from each gas turbine is routed to a dedicated HRSG producing superheated steam. This steam is used to power a steam turbine generator and to meet the needs of the Gasification Island and the overall plant.

DESCRIPTION OF ANALYSIS

The analysis was aimed at an assessment of the economic considerations for power generation using solid hydrocarbon feed, specifically Pittsburgh # 8 coal, processed in an IGCC mode, which employed BGL Gasification Technology and General Electric 7FA gas turbines.

The analysis defined a specific IGCC plant configuration as noted, and accordingly, plant capital and operating costs were defined using estimated costs for fuel feed and other required support streams. The cost of electrical power was calculated based on those parameters, and further analyzed by calculating variations of power cost as a function of varied capital costs and gasifier feed costs..6

As a parallel evaluation, the analysis also looked at the cost of power generation from natural gas fired combined cycle plants of similar capacity, using varied prices for natural gas. A comparison was made between these two fuel scenarios to allow reflection on potential market opportunities.

RESULTS

The analysis results are presented in detail in the attachments and show that IGCC power generation systems with solid hydrocarbon feeds can be competitive with natural gas fired combined cycle (NGCC) systems. Results show equivalent Cost of Electricity (COE) for IGCC and NGCC Systems at certain natural gas and gasifier feedstock prices. For example, natural gas at about $3.75/MBTU and coal at $1.00/MBTU will both yield a COE of 4.90 cents/KWh.

While these electrical power prices are not likely to stimulate consideration of the large capital investment required to build a self-sufficient project financed power plant, rising prices for natural gas clearly make IGCC increasingly attractive as an option for power generation.

An important factor, which has the potential to directly improve today's IGCC economics, is the utilization of the BGL gasifier unit's ability to handle a wide variety of fuel (feedstocks), including Refuse Derived Fuel (RDF). For example, a mixture of coal at $1.00/MBTU and RDF at $0.00/MBTU at a ratio of 50/50 by heat content equated to a gasifier feedstock price of $0.50. This places electricity generated from a BGL based IGCC on par with electricity from a NGCC if the price of natural gas is $3.00, within the range of annual average fuel costs considered reasonable by developers motivated to build an electric power plant.

CONCLUSIONS

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Macroeconomic forces have created an atmosphere today where use of gasification to produce power is a real and competitive alternative to natural gas. There are a number of Gasification Technologies that are commercially proven and in a state of readiness to establish new commercial projects based on IGCC concepts using solid hydrocarbon feeds. BGL Gasification Technology is one of those technologies, with its own unique attributes, and potential for further technical and economic enhancements through application of evolving Power Island technology, as well the as use of co-production scenarios, which provide additional impetus to favorable and improved project economics.

The specific results of the analysis performed indicate that:

- If high natural gas prices are sustained, IGCC will be the economic preference over NGCC in more future power generation projects; and
- Even if natural gas prices level off or decline slightly, the application of BGL gasification using a composite feedstock of coal and RDF will improve IGCC economics and make it.7 the technology of choice in more future power generation projects.

Furthermore, the following prospects have the potential to further improve IGCC economics:

- GE Power Systems technology developments such as the 7H and 9H Systems TM , rated in IGCC at 460 MW and 550 MW respectively, will further improve IGCC economics. The real cost of oxygen has historically dropped about 3% per year. Praxair's process, equipment, and systems development activities expect to provide similar improvements in the future.
- The co-production of materials such as hydrogen, methanol, ammonia, steam, plus Fischer-Tropsch generated liquid transportation fuel products will improve economics.
- Ongoing developments by Global Energy are also expected to contribute to further economic enhancements for IGCC projects. The know-how derived from these activities is expected to provide significant benefits to current and future BGL projects. There are three IGCC projects publicly announced by Global Energy in various stages of project development, each based on using BGL Gasification Technology in an IGCC scenario. Global Energy is also in the process of acquiring Berlinwasser's gasification co-production facility Sekundärrohstoff Verwertungszentrum Schwarze Pumpe GmbH (SVZ) Recycling Project in Schwarze Pumpe, Germany, as well as the right, title and interest in SVZ's proprietary gasification technology, including its gasification-related patents. The facilities also include a new BGL gasifier, further enhancing Global's knowledge of the BGL Gasification Technology.

A collective view of all of these ongoing events suggest that further significant improvements for IGCC economics are likely to occur, and that use of BGL Gasification Technology for IGCC

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**Campton, KY**
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projects can provide notable economic benefits to this rapidly growing market.

SUPPORTING CONTRIBUTORS TO PAPER

The companies supporting the analysis efforts include Global Energy, General Electric Power Systems, and Praxair. Each organization has significant involvement and presence in the rapidly growing IGCC industry as follows:

Global Energy

Global Energy Inc. is an international independent energy company with expertise in Gasification Technology, Alternative Fuels and Environmental Technology. The company is a founding member of the Washington, D.C.-based Gasification Technologies Council, together with General Electric, Texaco and 11 world-class companies. Global Energy is focused on Gasification Technology projects designed to improve environmental and economic results for the power, refining, chemical, steel, fuel cell, and pulp and paper industries. The company has.8 more than 5,000 MW of project activity in development, construction and operation in the Americas and Europe, with business development interests worldwide. The company is well aligned with the U.S. DOE's Vision 21 plan for Multi-fuel, Gasification Technology, Co-production systems.

General Electric Power Systems

GE Power Systems is one of the world's leading suppliers of power generation technology, energy services and management systems, with year 2000 revenue estimated at $14.5 billion. The business has the largest installed base of power generation equipment in the global energy business. GE Power Systems provides turnkey equipment, service and management solutions across the power generation, oil and gas, distributed power and energy rental industries.

Praxair

Praxair is a technology pioneer and global leader in the industrial gases industry. The company is the largest industrial gases company in North and South America, and one of the largest worldwide. Praxair is also a recognized leader in the commercialization of new technologies that bring productivity and environmental benefits to a diverse group of industries..9

SUPPORTING BACKGROUND REFERENCES

U.S. Department of Energy, "Clean Coal Technology - The Investment Pays Off", November 1999.

U.S. Department of Energy, "Clean Coal Technology Demonstration Program Project Fact Sheets", June 1999.

General Electric Power Systems, "Integrated Gasification Combined Cycle Gas Turbine Technology", 1999.

DePuy, et al., "From Coal or Oil to 550 MWe via 9H IGCC", Gasification Technology Conference, October 1999.

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U.K. Department of Trade and Industry, "Gasification of Solid and Liquid Fuels for Power Generation - Technology Status Report", December 1998.
U.S. Department of Energy, "Vision 21 - Clean Energy for the 21 st Century", November 1998.
U.S. Department of Energy, "Focus - Energy Solutions for the 21 st Century", September 1998.
U.K. Department of Enterprise, Coal R&D Report, "Integrated Gasification Combined Cycle Technology in the U.K. - Analysis of 300 MWe IGCC Power Plant", November 1992.
Bellinger, et al., "Clean Power - The BGL Gasifier", June 1987.
Scott, et al., "Application of the British Gas/Lurgi Slagging Gasifier for Combined Cycle Power Generation", International Consulting Service - British Gas plc, November 1985..10

ATTACHMENTS

A. Energy Information Agency (EIA) – US Gas and Oil Prices
B. Energy Information Agency (EIA) – Fossil Fuel Prices to Electric Utilities
C. BGL IGCC Process Diagram
D. Schematic Diagram of BGL Gasifier
E. Basic Analysis Assumptions

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**Appendix F**

Kentucky Revised Statute 224.010
(20) "Recovered material" means those materials, including but not limited to compost, which have known current use, reuse, or recycling potential, which can be feasibly used, reused, or recycled, and which have been diverted or removed from the solid waste stream for sale, use, reuse, or recycling, whether or not requiring subsequent separation and processing, but does not include materials diverted or removed for purposes of energy recovery or combustion except refuse-derived fuel (RDF), which shall be credited as a recovered material in an amount equal to that percentage of the municipal solid waste received on a daily basis at the processing facility and processed into RDF; **but not to exceed fifteen percent (15%) of the total amount of the municipal solid waste received at the processing facility on a daily basis;**

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**Appendix G**

The below is the first section of the Air Quality Permit, please note the Section 1 language regarding local permits.

Commonwealth of Kentucky
Natural Resources and Environmental Protection Cabinet
Department for Environmental Protection
Division for Air Quality
803 Schenkel Lane
Frankfort, Kentucky 40601
(502) 573-3382

AIR QUALITY PERMIT

Permittee Name:
Kentucky Pioneer Energy LLC

Mailing Address:
312 Walnut Street, Suite 2000, Cincinnati, Ohio 45202

Source Name:
Kentucky Pioneer Energy LLC

Mailing Address:
312 Walnut Street, Suite 2000, Cincinnati, Ohio 45202

Source Location:
12145 Irvine Road, Trapp, Kentucky 40391

Permit Type:
Federally-Enforceable

Review Type:
PSD, Title V

Permit Number:
V-00-049

Log Number:
51152

Application
Complete Date:
January 21, 2000

KYEIS ID #:
21-049-00053

SIC Code:
4911

ORIS Code:
5266

Region:
Bluegrass

County:
Clark

Issuance Date:
June 7, 2001

Expiration Date:
June 7, 2006

John E. Hornback, Director

DEP7001 (1-97)

Division for Air Quality

Revised 06/22/00

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| SECTION A PERMIT AUTHORIZATION | June 7, 2001 | 1 |

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SECTION A - PERMIT AUTHORIZATION

Pursuant to a duly submitted application which was determined to be complete on January 21, 2000, the Kentucky Division for Air Quality hereby authorizes the construction and operation of the equipment described herein in accordance with the terms and conditions of this permit. This draft permit has been issued under the provisions of Kentucky Revised Statutes Chapter 224 and regulations promulgated pursuant thereto.

The permittee shall not construct, reconstruct, or modify any emission units without first having submitted a complete application and receiving a permit for the planned activity from the permitting authority, except as provided in this permit or in the Regulation 401 KAR 50:035, Permits.

**Issuance of this permit does not relieve the permittee from the responsibility of obtaining any other permits, licenses, or approvals required by this Cabinet or any other federal, state, or local agency.**

References in this permit to regulatory requirements of 401 KAR 50:035 are based on the governing regulation which was in effect at the time the permit application was deemed complete. For future reference to the regulatory basis for permit conditions and for the purposes of implementation and compliance, the corresponding portions of the provisions of new permitting regulations in 401 KAR Chapter 52 (effective January 15, 2001) shall apply

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Appendix H

## Kentucky Resources Council, Inc.

Post Office Box 1070
Frankfort, Kentucky 40602
(502) 875-2428 phone (502) 875-2845 fax
e-mail FitzKRC@aol.com

December 13, 2001

Rob Daniell

Division of Waste Management By fax & e-mail only

14 Reilly Road

Frankfort, Kentucky 40601

Re: Global Energy, Inc.

Request for Determination Regarding Applicability

Of KRS 224.40.

Dear Director:

After a review of the position paper submitted by Global Energy to the state Division for Waste Management, and after review of the applicable statute and case law, I believe that the facility is subject to the solid waste regulations and is required to obtain a determination of consistency from the solid waste management governing body of Clark County before importing and disposing of the solid waste fuel through thermal treatment.

By letter dated October 9, 2000, Global Energy Inc., Suite 2000, 312 Walnut Street, Cincinnati, OH 45202, through its manager of Regulatory Affairs Dwight Lockwood, requested a determination from the Kentucky Division of Waste Management as to the applicability of KRS 224.40 to the proposed "integrated gasification combined cycle (IGCC) power plant project in Clark County."

The request letter from Global Energy (Hereafter Global) asserted that the proposed project was "exempt from waste regulations." The 2-paged letter contained an attached "Analysis of the Non-Applicability of KRS 224.40 to the Kentucky Pioneer Energy IGCC Project."

The determination of applicability of the waste regulations rests in the first instance with the Natural Resources and Environmental Protection Cabinet, subject always to review by the courts. KRS Chapter 224 is a statute that is remedial in nature and its protections are to be liberally with a view towards promoting the public and environmental protection goals of the statute. *Roland v. Kentucky Retirement Systems,* Ky.App.52 S.W.3d 579 (2001). Exemptions from its reach are to be narrowly construed.

The question of whether the proposed coal and waste-fueled facility is subject to the requirements of KRS Chapter 224 as a waste management and waste

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**Note:**
This is a copy of the letter read by Mr. Herrick at the Public Comment Hearing held in Trapp, Kentucky, on December 11, 2001. Comments from this letter heve been identified in the meeting transcript and the appropriate responses are located alongside the text. The meeting transcript begins on page D-302 of this appendix and this letter begins on page D-329.

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**Campton, KY**
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disposal facility is of significance to the residents of Trapp and of Clark County, since if exempted from the ambit of the term "municipal solid waste facility," the planned importation of processed municipal solid waste from northeastern states representing the equivalent of "roughly half of the residential waste generated in the entire Commonwealth of Kentucky" will not be subject to scrutiny and a determination by the local governing body of Clark County of the consistency with that county's approved solid waste plan.

When enacted in 1991, Senate Bill 2 substantially revised state and local solid waste management, requiring of local communities that they plan for the proper management of solid waste generated within their borders and promising, in return, that the local "governing body" responsible for solid waste planning would have the ability to control the manner and extent to which waste generated outside of the boundary of that planning unit would be managed and disposed of within the planning area.

The proposal to thermally treat and to combust the volatile fraction of one million tons or more per year of treated municipal solid waste falls squarely within the type of facility intended by the General Assembly to be scrutinized under the solid waste planning process.

KRS 224.40-315 mandates that:

> No permit to construct or expand a municipal solid waste disposal facility shall be accepted for processing by the Cabinet unless the application contains a determination from the governing body for the solid waste management area in which the facility is or will be located concerning the consistency of the application with the area solid waste Management plan [.]

The scope of this statute and the requirement for a determination of consistency with the approved solid waste plan is defined by the term "municipal solid waste disposal facility", which is defined in KRS 224.01-010(15) to include:

> Any type of waste site or facility where the final deposition of any amount of municipal solid waste occurs, whether or not mixed with or including other waste allowed under subtitle D of the Federal Resource Conservation and Recovery Act of 1976, as amended, and includes, but is not limited to, incinerators and waste-to-energy facilities that burn municipal solid waste. . . .

The term is broadly inclusive of all types of waste sites or facilities where the final deposition of any amount of municipal solid waste occurs. There can be no serious argument that the feed material to be combined with the coal is a solid waste, which is to say, that the material is "garbage, refuse, sludge and

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other discarded material." The waste is to be processed, according to the applicant, at a facility in a state other than Kentucky, where it will be manufactured from municipal solid waste by removing "large objects and white goods" as well as "glass and metal [.]" The remaining material, including chlorinated plastics, will be milled and shredded.

These "pellets" are municipal solid waste processed as an intermediate step in the thermal treatment of the waste to produce a gas for combustion. The proposed facility is utilizing a fuel stream comprised of partially separated, shredded and shaped municipal solid waste used as a fuel source, disposing of the waste through thermal treatment at high temperature to drive off the volatile fraction for combustion. As such, it is engaged in disposal of a municipal solid waste stream and falls within the ambit of a "municipal solid waste disposal facility" the siting and operation of which should be reviewed for consistency with local solid waste plans.

The applicant claims exemption for the waste fuel from the waste program as a "recovered material," yet the clearly better reading of the statute, and the intent to carefully regulate the disposal of solid waste by thermal treatment as well as other means, militates against the exemption of the material from regulation as a solid waste. The material is not a "refuse-derived fuel" notwithstanding the claim by the applicant to the contrary, since the applicant has indicated that it intends to retain the recoverable plastics in the waste (likely for the Btu value), and thus is outside of the ambit of "recovered material," since that definition specifically excludes "materials diverted or removed for purposes of energy recovery or combustion []" from being considered recovered material.

Assuming, for the sake of argument, that the waste were further processed over what is proposed, in order to meet the state definition of "refuse derived fuel" by removing all recoverable plastics and other recoverable material, such as mixed paper, corrugated paper and newsprint, the definition of "recovered material" still would not apply to exempt the entire waste stream from regulation since only 15% of the material processed by the facility creating the pellets could be credited as "RDF."

While the acceptance by the applicant of regulation under EPA's Municipal Solid Waste Combustor standards makes it difficult to accept at face value the assertion of non-applicability of state "waste" designation, commenter concurs that the state law itself determines how this facility is to be characterized for purposes of state regulation.

Because the material is not a "refuse derived fuel" under KRS 224.01-010(23) in that it has not been subject to "extensive separation of municipal solid waste" including "the extraction of recoverable materials for recycling" the processing of the municipal solid waste stream to create the palletized "fuel" does not make the material a "recovered material" under KRS 224.01-010(20). The proposed gasification step in the process and the cleaning of the volatile fraction of the waste for combustion does not make the facility a "recovered material processing facility" so as to exempt it from the definition of a municipal solid waste disposal facility or to avoid the obligation to be consistent with the local solid waste plan.

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Beyond the specific failure of the application to meet the criteria for an exempt "recovered material processing facility" because the waste feed will retain recoverable materials, including all plastics and paper, the *context* in which municipal solid waste disposal facilities are regulated under KRS Chapter 224 makes clear that the attempt to shoehorn this substantial waste-fueled energy facility into the category of a "recovered materials processing facility" is an ill-fit from a public policy standpoint. KRS 224.01-010, which contains many of the definitions for the chapter, is prefaced with the caveat "[a] s used in this chapter unless the context clearly indicates otherwise [.]" The statutory provision requiring a determination of local consistency for disposal facilities was plainly intended to cover thermal treatment of municipal solid wastes with and without energy recovery, and to segment the facility into the component processes in order to exclude from the application of KRS 224.40-315 a facility which uses a sequential process of thermal treatment followed by combustion of volatile gases, and which presents many similar concerns in management of air, water and solid waste byproducts from a heterogeneous fuel source such as municipal solid waste (even if homogenous in shape), is contrary to the intent of the statute and the public policy behind it.

In sum, the Council believes that the pelletized mixed municipal solid waste does not fall within the ambit of the state statutory definition of "refuse derived fuel" and is thus not a "recovered material." By definition, the facility is a "municipal solid waste disposal facility" under KRS 224.40-315(1), KRS 224.40-310 and KRS 224.01-010(15).

Commenter appreciates the Division's consideration of these comments in making a final determination as to the applicability of the waste statutes to the proposed facility.

Cordially,

Tom FitzGerald
Director

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## Kentucky Resources Council, Inc.

Post Office Box 1070
Frankfort, Kentucky 40602
(502) 875-2428 phone (502) 875-2845 fax
e-mail FitzKRC@aol.com

BEFORE THE DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY
COMMENTS CONCERNING DEIS FOR PROPOSED
KENTUCKY PIONEER ENERGY INTEGRATED GASIFICATION
COMBINED CYCLE DEMONSTRATION PROJECT

Dear Mr. Spears:

These preliminary comments are submitted regarding the proposed Kentucky Pioneer Energy IGCC Project Draft Environmental Impact Statement, and will be supplemented with extensive written comments concerning the project prior to the close of the comment period. As a preliminary matter, however, the Council was asked to address the relationship of the proposed project and the utilization of a shredded, milled and pelletized municipal solid waste fuel, to Kentucky's solid waste disposal statute and the requirement of maintaining consistency with local solid waste plans.

After a review of the position paper submitted by Global Energy to the state Division for Waste Management, and after review of the applicable statute and case law, I believe that the facility is subject to the solid waste regulations and is required to obtain a determination of consistency from the solid waste management governing body of Clark County before importing and disposing of the solid waste fuel.

By letter dated October 9, 2000, Global Energy Inc., Suite 2000, 312 Walnut Street, Cincinnati, OH 45202, through its manager of Regulatory Affairs Dwight Lockwood, requested a determination from the Kentucky Division of Waste Management as to the applicability of KRS 224.40 to the proposed "integrated gasification combined cycle (IGCC) power plant project in Clark County."

The request letter from Global Energy (Hereafter Global) asserted that the proposed project was "exempt from waste regulations." The 2-paged letter contained an attached "Analysis of the Non-Applicability of KRS 224.40 to the Kentucky Pioneer Energy IGCC Project."

The determination of applicability of the waste regulations rests in the first instance with the Natural Resources and Environmental Protection Cabinet, subject to review by the courts. KRS Chapter 224 is a statute that is remedial in nature and its protections are to be broadly construed consistent with the

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**Campton, KY**
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public and environmental protection goals of the statute. Exemptions from its reach are to be narrowly construed.

The question of whether the proposed coal and waste-fueled facility is subject to the requirements of KRS Chapter 224 as a waste management and waste disposal facility is of significance to the residents of Trapp and of Clark County, since if exempted from the ambit of the term "municipal solid waste facility," the planned importation of processed municipal solid waste from northeastern states representing the equivalent of "roughly half of the residential waste generated in the entire Commonwealth of Kentucky" will not be subject to scrutiny and a determination by the local governing body of Clark County of the consistency with that county's approved solid waste plan.

When enacted in 1991, Senate Bill 2 substantially revised state and local solid waste management, requiring of local communities that they plan for the proper management of solid waste generated within their borders and promising, in return, that the local "governing body" responsible for solid waste planning would have the ability to control the manner and extent to which waste generated outside of the boundary of that planning unit would be managed and disposed of within the planning area.

The proposal to thermally treat and to combust the volatile fraction of one million tons or more per year of treated municipal solid waste falls squarely within the type of facility intended by the General Assembly to be scrutinized under the solid waste planning process.

KRS 224.40-315 mandates that:

> No permit to construct or expand a municipal solid waste disposal facility shall be accepted for processing by the Cabinet unless the application contains a determination from the governing body for the solid waste management area in which the facility is or will be located concerning the consistency of the application with the area solid waste Management plan [.]

The scope of this statute and the requirement for a determination of consistency with the approved solid waste plan is defined by the term "municipal solid waste disposal facility", which is defined in KRS 224.01-010(15) to include:

> Any type of waste site or facility where the final deposition of any amount of municipal solid waste occurs, whether or not mixed with or including other waste allowed under subtitle D of the Federal Resource Conservation and Recovery Act of 1976, as amended, and includes, but is not limited to, incinerators and waste-to-energy facilities that burn municipal solid waste, . . .

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The term is broadly inclusive of all types of waste sites or facilities where the final deposition of any amount of municipal solid waste occurs. There can be no serious argument that the feed material to be combined with the coal is a solid waste, which is to say, that the material is "garbage, refuse, sludge and other discarded material." The waste is to be processed, according to the applicant, at a facility in a state other than Kentucky, where it will be manufactured from municipal solid waste by removing "large objects and white goods" as well as "glass and metal [.]" The remaining material, including chlorinated plastics, will be milled and shredded.

These "pellets" are municipal solid waste processed as an intermediate step in the thermal treatment of the waste to produce a gas for combustion. The proposed facility is utilizing a fuel stream comprised of partially separated, shredded and shaped municipal solid waste used as a fuel source, disposing of the waste through thermal treatment at high temperature to drive off the volatile fraction for combustion. As such, it is engaged in disposal of a municipal solid waste stream and falls within the ambit of a "municipal solid waste disposal facility" the siting and operation of which should be reviewed for consistency with local solid waste plans.

The applicant claims exemption for the waste fuel from the waste program as a "recovered material," yet the clearly better reading of the statute, and the intent to carefully regulate the disposal of solid waste by thermal treatment as well as other means, militates against the exemption of the material from regulation as a solid waste. The material is not a "refuse-derived fuel" notwithstanding the claim by the applicant to the contrary, since the applicant has indicated that it intends to retain the recoverable plastics in the waste (likely for the Btu value), and thus is outside of the ambit of "recovered material," since that definition specifically excludes "materials diverted or removed for purposes of energy recovery or combustion []" from being considered recovered material.

Assuming, for the sake of argument, that the waste were further processed over what is proposed, in order to meet the state definition of "refuse derived fuel" by removing all recoverable plastics and other recoverable material, such as mixed paper, corrugated paper and newsprint, the definition of "recovered material" still would not apply to exempt the entire waste stream from regulation since only 15% of the material processed by the facility creating the pellets could be credited as "RDF."

While the acceptance by the applicant of regulation under EPA's Municipal Solid Waste Combustor standards makes it difficult to accept at face value the assertion of non-applicability of state "waste" designation, commenter concurs that the state law itself determines how this facility is to be characterized for purposes of state regulation.

Because the material is not a "refuse derived fuel" under KRS 224.01-010(23) in that it has not been subject to "extensive separation of municipal solid waste" including "the extraction of recoverable materials for recycling" the processing of the municipal solid waste stream to create the palletized "fuel" does not make the material a "recovered material" under KRS 224.01-010(20). The proposed gasification step in the process and the cleaning of the

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**Campton, KY**
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volatile fraction of the waste for combustion does not make the facility a "recovered material processing facility" so as to exempt it from the definition of a municipal solid waste disposal facility or to avoid the obligation to be consistent with the local solid waste plan.

Beyond the specific failure of the application to meet the criteria for an exempt "recovered material processing facility" because the waste feed will retain recoverable materials, including all plastics and paper, the *context* in which municipal solid waste disposal facilities are regulated under KRS Chapter 224 makes clear that the attempt to shoehorn this substantial waste-fueled energy facility into the category of a "recovered materials processing facility" is an ill-fit from a public policy standpoint. KRS 224.01-010, which contains many of the definitions for the chapter, is prefaced with the caveat "[a] s used in this chapter unless the context clearly indicates otherwise [.]" The statutory provision requiring a determination of local consistency for disposal facilities was plainly intended to cover thermal treatment of municipal solid wastes with and without energy recovery, and to segment the facility into the component processes in order to exclude from the application of KRS 224.40-315 a facility which uses a sequential process of thermal treatment followed by combustion of volatile gases, and which presents many similar concerns in management of air, water and solid waste byproducts from a heterogeneous fuel source such as municipal solid waste (even if homogenous in shape), is contrary to the intent of the statute and the public policy behind it.

In sum, the palletized mixed municipal solid waste does not fall within the ambit of the state statutory definition of "refuse derived fuel" and is thus not a "recovered material." By definition, the facility is a "municipal solid waste disposal facility" under KRS 224.40-315(1), KRS 224.40-310 and KRS 224.01-010(15).

Commenter suggests that DOE undertake these actions in order to assure full compliance with applicable state laws prior to engaging in funding support for this project:

1. request and await final determination by the Natural Resources and Environmental Protection Cabinet as to the applicability of the waste statutes to the proposed facility;
2. assuming the applicability of the statutes, defer the funding decision until the applicant demonstrates the viability of the project by obtaining a determination of consistency from the governing body of the solid waste management area covering Clark County of the proposed importation and utilization of the solid waste material for the facility; and
3. extending to the Governing Body of that solid waste management area the opportunity to participate in the EIS review process as a cooperating agency.

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**Campton, KY**
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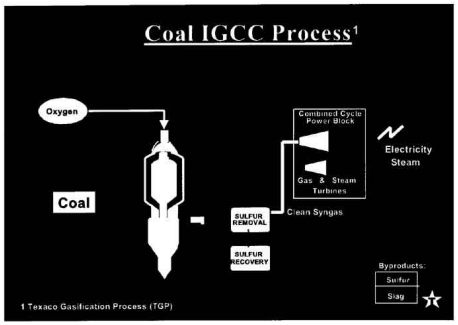
**Increasing Electricity Availability From Coal-Fired Generation in the Near-Term**
**May 2001**




**THE NATIONAL COAL COUNCIL**

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**Increasing Electricity Availability From Coal-Fired Generation in the Near-Term**

**Chair:** Mr. Steven F. Leer

**Vice Chair:** Mr. Wes M. Taylor

**Study Work Group Chair:** Ms. Georgia Nelson

**The National Coal Council**
**May 2001**

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**THE NATIONAL COAL COUNCIL**

**Steven F. Leer, Chairman**

**Robert A. Beck, Executive Director**

**U.S. DEPARTMENT OF ENERGY**

**Spencer Abraham, Secretary of Energy**

**The National Coal Council is a Federal Advisory Committee to the Secretary of Energy. The sole purpose of the National Coal Council is to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary relating to coal or to the coal industry.**

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## Cover Letter to Secretary Abraham

**NATIONAL COAL COUNCIL, INC.**
1730 M Street, NW • Suite 907
Washington, DC 20036
PHONE: 202-223-1191
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*Website Address: nationalcoalcouncil.org*

May 3, 2001

The Honorable Spencer Abraham
Secretary of Energy
United States Department of Energy
Room 7A-219
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Mr. Secretary:

On behalf of The National Coal Council I am pleased to submit the enclosed report entitled "Increasing Electricity Availability from Coal-Fired Generation in the Near-Term." This report was authorized by your predecessor then-Secretary Bill Richardson, on November 13, 2000 prepared, deliberated and recommended by the Coal Policy Committee at its meeting on April 3, 2001, and formally approved by The National Coal Council on May 3, 2001.

In his letter, Secretary Richardson requested that The National Coal Council conduct a study on measures, which the government or government in partnership with industry, could undertake to improve the availability of electricity from coal-fired power plants. His letter requested that the Council address improving coal-fired generation availability in two specific areas:

- Improving technologies at coal-fired electric generating plants to produce more electricity, and
- Reducing regulatory barriers to using these technologies.

The Council accepted Secretary Richardson's request and formed a study group of experts to conduct the work. The study group conducted its work at the direction of the Coal Policy Committee of the Council, which is chaired by Malcolm Thomas, Vice President of Kennecott Energy and a member of the Council. The study group itself was chaired by Georgia Nelson, President of Midwest Generation Company and a member of the Council.

The study was divided into two major sections: technologies and regulatory reform. The focus of the technologies section is on achieving more electricity from existing and new coal-fired power plants using technologies that improve efficiency, availability and environmental performance in the near term defined as the next 36 months.

However, unless there is a significant change in regulatory interpretation and enforcement regarding the installation of new technologies at existing power plants, it is not likely that any of this additional low-cost, low-cost emission electricity will be produced. The recent change in enforcement procedures by EPA, reinterpreting as violations of the Clean Air Act what had heretofore been considered routine maintenance at power plants, has had a direct and chilling effect on all maintenance and efficiency improvements, and clean coal technology installations at existing power plants. A return to the pre-1998

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interpretation of this one regulation would allow plant operators the opportunity to install technologies discussed in the report.

Several other existing regulations seem to be in conflict with the country's attempt to maximize the use of domestic energy sources, as well. Environmental regulation should be harmonized with the energy and national security goals of the country.

The National Coal Council strongly recommends that the country, with the Department of Energy in the lead, develop a clear comprehensive energy policy that supports the maximum use of domestic fuel sources, continues to protect the environment by implementing strong but balanced environmental regulations, and harmonizes conflicting regulations affecting energy development and use. Government and the private sector should work in partnership to achieve the desired goals and remove those regulatory barriers that create obstacles to achieving those goals, while preserving environmental performance. The specific recommendations of the Council can be found in the Executive Summary of the report.

The Council appreciates being asked to provide this report and we stand ready to answer any questions you may have about it.

Sincerely,

Steven F. Leer
Chairman

Enclosure

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## Abbreviations

| | |
|---|---|
| AQRVs | Air quality related values |
| B&W | Babcock & Wilcox |
| BACT | Best available control technology |
| BGL | British Gas/Lurgi |
| Btu | British thermal units |
| Btu/kWh | British thermal units per kilowatt-hour |
| CAA | Clean Air Act |
| CFB | Circulating fluidized bed |
| $CO_2$ | Carbon dioxide |
| COS | Carbonyl sulfide |
| DOE | Department of Energy |
| EIA | Energy Information Administration |
| EPA | Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| FGD | Flue gas desulfurization |
| FLMS | Federal land managers |
| GADS | Generation Availability Data System |
| GW | Gigawatts ($10^9$ watts) |
| HHV | Higher heating value |
| HRSG | Heat recovery steam generator |
| IGCC | Integrated gasification combined cycle |
| kW | Kilowatt |
| lb/MBtu | Pounds of emissions per million Btu of heat input |
| LAER | Lowest achievable emission rates |
| LHV | Lower heating value |
| LNB | Low $NO_x$ burners |
| MACT | Maximum achievable control technology |
| Mbtu | Million Btu |
| MDGC | Maximum demonstrated generating capacity |
| MW | Megawatts ($10^6$ watts) |
| MWH | Megawatt-hour |
| NAAQS | National Ambient Air Quality Standards |
| NCC | National Coal Council |
| NERC | North American Electric Reliability Council |
| NGCC | Natural gas combined cycle |
| NOVs | Notices of violation |
| $NO_x$ | Nitrogen oxides |
| NSPS | New Source Performance Standards |
| NSR | New Source Review |
| O&M | Operating and Maintenance |
| OEM | Original Equipment Manufacturer |
| PPM | Parts Per Million |
| PSD | Prevention of significant deterioration |
| SCR | Selective catalytic reduction |
| $SO_2$ | Sulfur dioxide |
| $SO_x$ | Sulfur oxides |
| tpy | tons per year |
| UDI | Utility Data Institute |
| WEPCo | Wisconsin Electric Power Company |

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## Preface

The National Coal Council is a private, nonprofit advisory body, chartered under the Federal Advisory Committee Act.

The mission of the Council is purely advisory: to provide guidance and recommendations as requested by the United States Secretary of Energy on general policy matters relating to coal. The Council is forbidden by law from engaging in lobbying or other such activities. The National Coal Council receives no funds or financial assistance from the Federal government. It relies solely on the voluntary contributions of members to support its activities.

Members of the National Coal Council are appointed by the Secretary of Energy for their knowledge, expertise, and stature in their respective fields of endeavor. They reflect a wide geographic area of the United States (representing more than 30 states) and a broad spectrum of diverse interests from business, industry, and other groups, such as:

- large and small coal producers;
- coal users such as electric utilities and industrial users;
- rail, waterways, and trucking industries as well as port authorities;
- academia;
- research organizations;
- industrial equipment manufacturers;
- state government, including governors, lieutenant governors, legislators, and public utility commissioners;
- consumer groups, including special women's organizations;
- consultants from scientific, technical, general business, and financial specialty areas;
- attorneys;
- state and regional special interest groups; and
- Native American tribes.

The National Coal Council provides advice to the Secretary of Energy in the form of reports on subjects requested by the Secretary and at no cost to the Federal Government.

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## Executive Summary

### Purpose

By letter dated November 13, 2000, then-Secretary of Energy Bill Richardson requested that the National Coal Council conduct a study on measures which the government or the government in partnership with industry could undertake to improve the availability of electricity from coal-fired power plants. His letter requested that the Council address improving coal-fired generation availability in two specific areas:

- improving technologies at coal-fired electric generating plants to produce more electricity; and
- reducing regulatory barriers to using these technologies.

The Council accepted the Secretary's request and formed a study group of experts to conduct the work and draft a report. The list of participants of this study group can be found in Appendix D of the report.

### Findings

The study group found the following.

- Nationally, approximately 40,000 megawatts of increased electrical production capability is possible now from existing coal-fired power plants.
- Such increased electricity supply can be available through the installation of standard improvements and clean coal technologies. This will have the important effect of increasing efficiency and decreasing emissions per megawatt from such modified plants, thereby improving air quality.
- Such plant efficiency and increased electricity production capability may only be realized if a return to historic regulatory policy is made.
- Coal-based electricity will be important for many years into the future. Therefore, regulations and policies employed should encourage the clean use of this resource through accelerated installation of more efficient, cleaner technologies.

The study was divided into two major sections: technology and regulatory reform. The focus of the technology section is on achieving more electricity from existing and new coal-fired power plants using technologies that improve efficiency, availability, and environmental performance. The discussion is divided into three subsections:

a) achieving higher availability/reliability in the existing fleet of coal-fired plants;
b) Increasing generation output of existing coal-fired plants; and
c) Determining opportunities for repowering existing facilities with clean coal technologies as well as building new advanced clean coal technology generation facilities.

Analysis of the U.S. utility industry infrastructure of coal plants reveals a significant potential for increasing generation capacity by taking well-tested measures to improve the reliability/availability of older facilities. This effort, which will come mainly from improvements on the steam generators of these older plants, can create 10,000 MW of new capacity.

Techniques to recover lost capacity and increase capacity above nameplate have been collected from a combination of research studies by utility industry organizations such as EPRI and actual case studies which are detailed in the report. The nameplate capacity of coal units older than 20 years is approximately 220,000 MW; however, due to derating, the existing capacity is only about 200,000 MW.

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This group of plants has the potential for both capacity restoration (about 20,000 MW) and/or improvement (about 20,000 MW). It is estimated that this increased capacity of 40,000 MW could be recovered within 36 months. This can allow the economy to grow while new generation facilities are sited, constructed, and brought into service.

For new coal-fired power generating capacity, Pulverized Coal Combustion in supercritical steam plants (a mature technology) is available with minimal emissions, high efficiency, and at very favorable total production cost.

Repowering of an old existing coal fired power plant with a single modern steam generating unit, equipped with commercially proven emissions controls results in significant reductions in the total amounts of emissions even while substantially increasing the total MWh output of the facility.

Integrated Gasification Combined Cycle (IGCC) has become a commercially available technology for both greenfield and repowering applications. IGCC is a clean, new technology option insensitive to fuel quality variation.

While natural gas will fuel the majority of new capacity additions during this time period there are currently about 321,000 MW of coal-fired capacity in service. While not all of this capacity can be targeted for the new technologies discussed in this report, it is estimated that 75% of it can be retrofitted with one of these technologies. This additional increase in capacity is estimated to be 40,000 MW and much of it could be brought on line in the next three years. This minimizes economic impacts while new generation facilities are sited, constructed, and brought into service without increasing emissions at existing facilities and, in some cases, lowering emissions. Approximately 25% of existing facilities can be targeted for repowering with much cleaner and more efficient coal-based power generation.

However, unless there is a significant change in regulatory interpretation and enforcement regarding the installation of new technologies at existing power plants, it is not likely that any of this additional low-cost, low emission electricity will be produced. The recent change in enforcement procedures by EPA (reinterpreting as violations of the Clean Air Act what had heretofore been considered routine maintenance at power plants) has had a direct and chilling effect on all maintenance and efficiency improvements and clean coal technology installations at existing power plants. EPA has brought legal action against 11 companies and 49 generation facilities since 1998 under the New Source Review section of the 1990 Clean Air Act. The companies involved believe that they were conducting routine maintenance needed to keep these plants in good condition. The result has been that no new efficiency, availability, or environmental improvement has occurred since 1998 when EPA changed its enforcement policy. A return to the historic interpretation of this one regulation alone would allow plant operators the opportunity to install technologies discussed in the report. If just a three percent increase in capacity could be achieved through reducing outages and increasing plant efficiency, it could result in over 11,500 MW of coal-based capacity being added to the current fleet while continuing the downward trend in emissions.

Several other existing regulations seem to be in conflict with the country's attempt to maximize the use of domestic energy sources. Environmental regulation should be harmonized with the energy and national security goals of the country.

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**Recommendations**

The National Coal Council strongly recommends that the country, with the Department of Energy in the lead, develop a clear, comprehensive energy policy that supports the maximum use of domestic fuel sources, continues to protect the environment by implementing strong but balanced environmental regulations, and harmonizes conflicting regulations affecting energy development and use. Government and industry should work in partnership to achieve the desired goals and remove those regulatory barriers that create obstacles to achieving those goals while preserving environmental performance.

Specifically, the Council recommends that the Department of Energy take the following actions.

- Initiate and lead a dialogue with EPA, with the goal of returning to the traditional pre-1998 interpretation of the New Source Review section of the 1990 Clean Air Act.
- Promote accelerated installation of clean and efficient technologies at new and existing coal-fired power plants.
- Initiate and lead a dialogue with EPA to promote coordinated regulations for ozone attainment into a single compliance strategy.
- Initiate and lead a dialogue with EPA and electricity generators to establish credible and uniform emissions targets, which will provide regulatory certainty for a sufficient period in the future to assure electricity generators that they can achieve a return on investments for performance and environmental improvements.
- Lead the country's effort to develop a clear, comprehensive, and secure energy policy that maximizes the use of domestic fuels, including coal, while continuing the downward trend in emissions.

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## Achieving Higher Availability/Reliability From Existing Coal-Fired Power Plants

This section will focus on recommendations that will improve existing coal-fired power plants' reliability and availability to eliminate or reduce forced outages and extend the time between planned maintenance outages. This suggested availability improvement program is meant to restore the plants' infrastructure to a level that restores the original reliability of the plants. Implementation of these recommendations will allow the plants to increase generation output above recent historical output without increasing gross generating capability.

We will show from the use of industry sources on reliability (GADS/NERC) and generation capacity (EIA) that there is a significant opportunity for the utility industry to increase the generation output from our existing fleet of coal-fired power plants by restoring portions of the plant infrastructure to their original condition.

Analysis of the U.S. utility industry's coal-fired plant infrastructure reveals a significant opportunity for increasing electricity output from these plants by taking measures to improve the reliability/availability of the older facilities. Maintaining or restoring plants that are over 20 years old to a condition similar to plants that are under 20 years old can result in more reliable facilities that will be available to play an important role in supporting the increasing strain on our electrical system's reserve margins and electrical demand growth.

Specifically, our analysis has shown that this reliability improvement effort can create 10,000 MWs of equivalent generation capacity within our existing coal-fired fleet of plants. Of particular note is that over 90% of these MWs of capacity will come from component replacement and material upgrades of the boiler/steam generator at our facilities that are more than 20 years old. The U.S. EPA has focused on boiler/steam generator component replacement projects in its recent enforcement actions, applying New Source Review ("NSR") standards to repairs formerly considered routine maintenance, repair, or replacement. The potential regulatory consequences of the EPA's enforcement actions may prevent the utility industry from taking full advantage of this relatively inexpensive way to increase the availability of our national electric generating capacity, which could be implemented in a two to three year time frame.

The U.S. electric generating system's reserve margins have declined dramatically over the last 20 years. This situation has put pressure on the operators of our existing coal-fired fleet to restore, maintain, or improve the reliability and availability of their facilities to keep pace with the growing demand for electricity in the face of limited new capacity coming on line. The mandate for higher availability, lower forced outage rates, and longer time spans between planned outages is more critical today than ever in our history.

The causes of plant unavailability are well defined, and sound, technology-based solutions are commercially available to improve plant availability and help restore our historic reserve margins.

Causes of plant unavailability and recommendations for solutions have been generally categorized according to the magnitude of their impact on plant availability in the following list:

**Area 1: Boiler/Steam Generator**
The primary cause of unavailability of our coal-fired plants is the reliability of the boiler/steam generator. Severe duty on both the fire side and the water/steam side of the various heat transfer surfaces in the boiler/steam generator cause frequent unplanned outages and lengthening of planned outages to repair

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failures to these critical components of the power plant. Replacement of these components will significantly reduce outages and increase the facility's availability and total generation output capability. Examples of our recommendations for improving the availability of the boiler/steam generator are:

a. furnace wall panel replacements;
b. reheater component replacements;
c. primary superheater component replacements;
d. secondary superheater component replacements;
e. economizer replacements;
f. various header replacements;
g. furnace floor replacements;
h. cyclone burner replacements; and
i. incorporation of improved materials of construction for items a-h.

This area represents between 50% and 70% (depending on age, design, and operating history of the unit) of all lost generation from our coal-fired fleet. The industry data sources referenced above indicate that if improvements to the boilers/steam generators on our plants that are older than 20 years can be made to restore these facilities to the condition of plants that are under 20 years, we will benefit from an attendant improvement in reliability/availability. To help quantify this finding, plants older than 20 years are, on average, currently experiencing nearly 10% loss of achievable generation due to problems in the boiler/steam generator. This compares to approximately 5% loss for plants that are less than 20 years old. If we can recover only this differential through restoration of the boiler/steam generator, we will be taking advantage of nearly 9,000 MWs of available generation capacity in our existing coal-fired generating fleet. This figure is expected to increase significantly as our older generating units are dispatched more often to meet the growing demand for electricity considering the less than adequate new capacity coming on line.

Although the implementation of any (or all) of these recommendations will significantly increase plant availability, recent regulatory treatment of previously routine repairs, maintenance, and replacement as modifications by the EPA discourages utilities from pursuing these kinds of projects in their future plans for availability improvement for fear of triggering NSR with accompanying permitting and modeling requirements. NSR can radically undermine the economic feasibility of these projects, preventing recapture of lost generating capacity or increased reliability.

**Area 2: Steam Turbine/Generator**

Problems with the steam turbine/generator represent the second largest source of reduced generation capability in coal-fired plants. This area represents a 3% loss of generation compared to up to 10% for the boiler/steam generator. An interesting finding from our analysis is that the data sources referenced above show very little difference in loss of generation capability due to turbine/generator problems between plants older than 20 years and plants younger than 20 years. This phenomenon may be due to the regimented safety and preventative maintenance program typically mandated by turbine manufacturers and followed by plant owners for the steam turbine/generator.

Section 2 describes turbine/generator improvements (e.g., uprating) that can change gross plant outputs without changing the turbine/generator's relatively good track record on availability. In addition to turbine uprating, some of the general improvements that have occurred in steam turbine design will also improve the availability/reliability of existing steam turbines. Recommendations include:

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a. turbine blading replacements with improved shapes (CFD modeling) and materials of construction to increase turbine efficiency and reliability;
b. implementation of measures to reduce or eliminate droplet formation and the resultant blade erosion preserving turbine reliability and performance; and
c. turbine/generator inclusion in plant diagnostic and data acquisition system for predictive maintenance (reference area 7c below) to reduce unnecessary maintenance and associated outage time.

**Area 3: Plant Auxiliaries**
This area focuses on plant auxiliaries including the air heater, feedwater system, cooling water systems, electrical systems, etc. Plant auxiliaries cause approximately 1-2% of lost megawatt-hour (MWh) generation from our coal-fired plants over 20 years old. This can be improved to under 1% with restoration of critical components in this area of the plant. Some examples of recommendations for improved reliability and increased operating efficiencies in these areas are:

a. air heater or air heater basket replacement with the attendant modern sealing systems;
b. improved air heater surface design and cleaning system installation to address fouling;
c. feedwater heater retubing or replacement with upgraded materials to reduce failure rates; and
d. cooling tower fill improvements.

**Area 4: Environmental (Focus on Electrostatic Precipitators)**
Precipitator performance has the fourth largest impact on loss of plant availability. This problem almost always manifests itself in the form of load curtailment caused by the potential for opacity excursions. To exacerbate the problem, these curtailments typically occur at very critical capacity supply situations such as periods with high load requirements. Recommendations for mitigation are:

a. collection plate and electrode upgrades and/or replacement;
b. collection surface additions (new fields);
c. various flue gas treatment system installations;
d. addition of modern control system installations; and
e. general correction of leakage and corrosion problems.

**Area 5: Fuel Flexibility**
Many utilities have expanded their coal purchase specifications to leverage the variability in the cost of coal as a means of providing low-cost electricity to their customers. This practice, however, can have an adverse affect on plant reliability due to stress on the plant. It should be noted that although this area is not statistically recognized as a cause of loss of plant availability, fuel related problems are a major part of loss of availability from Area 1 "boiler/steam generator" due to such phenomena as boiler slagging/fouling, limited pulverizer throughput, reduced coal grindability, inadequate primary air systems, etc. Recommendations to reduce or eliminate these limitations are:

a. coal handling system upgrades to accommodate lower Btu coal;
b. mill upgrades to accommodate reduced grindability of coal;
c. ash (bottom and/or fly) system upgrades to accommodate higher ash coal or different ash classes;
d. additional furnace-cleaning equipment to mitigate different slagging and fouling characteristics of the coals;
e. draft system upgrades including FD fans, ID fans, combustion air temperature, and related electrical systems to accommodate higher gas volume flow rates; and

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f. precipitator upgrades to accommodate changes in fly ash resistivity and/or quantity.

**Area 6: Boiler Water Treatment**
This issue goes hand-in-hand with Area 1 described above. Performance of boiler heat transfer surface is highly dependent on the chemistry of the water/stream that keeps the surface cool. Upgrades of the boiler water treatment system should be coordinated with the upgrades described in Area 1. An added benefit of higher water purity standards is faster plant start-ups; and, therefore, a unit can come on-line more quickly and ramp up generation faster resulting in a higher overall generation output. In addition, water purity has a cascading effect increasing the reliability of feedwater heaters and turbine blades and improving condenser performance.

**Area 7: Controls and Plant Diagnostic Systems**
Modern digital control and diagnostic systems can improve heat rates (generation efficiency), lower emissions, reduce plant startup times, and provide valuable information for outage planning. Recommendations in this regard include:

a. replacement of outdated analog control with advanced digital control systems;
b. replacement and/or addition of instrumentation for better control of the unit over a wider range of loads and improved monitoring of critical system components for outage planning;
c. installation of plant diagnostic and data acquisition systems to perform predictive maintenance reducing unplanned outages and extending on-line time durations between planned outages; and
d. installation of turbine bypass system hardware and controls to facilitate lower load capabilities, faster unit start-ups and faster ramp rates increasing overall unit productivity.

**Area 8: Plant Heat Rejection**
For many plants, the highest capacity requirements of the year occur at the same time that they experience severe heat rejection limitations. Summertime cooling lake and river temperatures/water levels can cause load curtailments. Recommendations include:

a. water intake structure modifications to provide more flexibility during low water levels;
b. cooling tower additions to provide an alternate heat rejection mechanism; and
c. cooling lake design modifications (additional surface, redirected flow path, etc.) to increase heat rejection capability.

**Summary**

Restoration of our 20+-year-old coal-fired plants to a condition similar to those that are under 20 years through the recommendations described in these eight areas can create approximately 10,000 MWs of additional availability from existing assets. We would expect this number to grow significantly as we increase utilization of our older plants to meet growing demand. Without implementing these recommendations, the forecasted increases in utilization will accelerate failures in these older facilities increasing the need for the recommendations we have identified here.

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Of particular interest is that 90% of the increased availability identified will come from component replacement and other projects involving the boiler/steam generator. The boiler/steam generator has been the focus of the EPA's allegations in its recent reinterpretation of the New Source Review program as part of its power plant enforcement initiative.

### Increasing Generation Output of Existing Units

The maximum demonstrated generating capacity (MDGC) of coal units older than 20 years, as identified above, is conservatively estimated to total approximately 220,000 MWs. The existing operating capacity is estimated to be 200,000 MWs (due to deratings). This group of plants has the potential for both capacity restoration (20,000 MWs) and/or capacity maximization (20,000 MWs). Thus, the total amount of potential increased MW output of this existing group of units is approximately 40,000 MWs. This increased capacity could be achieved within 36 months.

If all existing conditions resulting in a derating could be addressed, approximately 20,000 MWs of increased capacity could be obtained from regaining lost capacity due to unit deratings. This increase would be achieved using the approaches and techniques in Table 1 below.

Approximately an additional 20,000 MWs of capacity could be gained if it were possible to increase heat input and/or electrical output from generating equipment while still maintaining the acceptable design margins and allowable code ratings of the equipment. The approaches and techniques would be similar to those for regaining capacity, as indicated in Table 1.

These approaches and techniques could only be logically pursued by the facility owners if it was clearly understood that the increased availability and/or electrical output would not trigger New Source Review (NSR) and if repowering or construction of new clean coal technologies would be subject to the streamlined permitting authorized by the 1990 CAA Amendments.

The techniques to recover lost capacity and to increase capacity above MDGC have been collected from a combination of research studies by utility industry organizations (such as EPRI) and actual case studies (such as those outlined below) which had benefits for plant owners. They are summarized in Table 1 below.

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**TABLE 1**
**Techniques and Approaches for Coal-Fired Power Plants Capacity Restoration and Increase**

| Capacity Increase Method | Capacity Restoration | Efficiency/ Capacity Increase | Fuel Conversion/ Repowering |
|---|---|---|---|
| Installation of improved air pollution control equipment | X | X | X |
| Steam turbine modernization improvements and upgrades | X | X | |
| Coal washing | X | X | |
| Coal switching | X | X | |
| Repowering with CFB technology | | | X |
| Consolidation of multiple, smaller inefficient units to larger, more efficient units | | X | X |
| Operating above the nameplate but within the plant design | X | X | |
| Control system improvements | X | X | |
| Plant efficiency improvements | X | X | |

The techniques and approaches listed in Table 1 have been implemented with proven results. The following highlights are from case studies.

- *SCR and FGD emissions control equipment was installed on a coal- fired generating station to reduce emissions of SOx and NOx. In order to offset the increased auxiliary load (16 MWs) of these new systems, an upgrade of the original 500-MW (nominal rating) steam turbine was performed. The upgrade consisted primarily of a new high-efficiency, high-pressure rotor with increased number of stages and an optimized steam path. The upgrade resulted in an output increase of approximately 15 MWs, almost offsetting the auxiliary load increase from the new emission controls.*
- *Turbine upgrades were completed on two 400-MW rated units to obtain an additional 25 MWs per unit. No additional steam was required from the boiler. No changes were made to the boiler. A more aerodynamic steam path through the turbine was designed and installed.*
- *Turbine upgrades were incorporated into another unit, nominally rated at 500 MWs achieving an additional 25 MWs. In this case, more steam had to be generated in the boiler and the steam turbine was upgraded.*
- *Coal cleaning is a process whereby a coal that is high in ash and sulfur is "washed." As a result, the coal is lower in both ash and sulfur content and higher in thermal value. The method consists of a multi-circuit wet process where water is used for screening and separation. Coal cleaning is a cost-effective means of separating ash and sulfur from coal, which in turn reduces opacity and $SO_2$ emissions. This enables one facility to continue to use local, lower cost, higher ash and sulfur coal and meet environmental limits. Without this coal cleaning process, the facility's load would be limited by approximately 10% due to opacity restrictions.*
- *Coal switching is an alternative to coal cleaning. In some cases where coal has been switched to reduce SOx emissions, the capacity may be impaired unless fuel handling systems are upgraded to allow efficient use of lower sulfur fuels.*
- *Repowering with CFB technology is an alternative to installing NOx and SOx emissions equipment. The use of this technique is highly site and fuel specific.*
- *Capacity increases can be accomplished by taking a brownfield site with several smaller old units, and repowering the site with a single large unit. This will require the full environmental permitting*

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*process. It is a technique that is highly site specific and economically driven. To make the economics attractive, it is important that the units are running at low dispatch levels, so income losses are minimized, and the site can be readily cleared for construction of the larger unit.*

- *Control system improvements can increase capacity in older plants. Modern control systems can improve efficiency and reduce emissions by optimizing the combustion process. General improvements to plant efficiency can be obtained by improved operating and maintenance practices along with targeted equipment improvements.*

Note: The additional 20,000 MW that can be achieved by capacity restoration described in this section includes the 10,000 MW of capacity that can be recovered due to deteriorated availability described earlier in the report.

## Opportunities for Greenfield Sites and Repowering Existing Facilities with Pulverized Coal Power Generation

As a result of ongoing technology development, new and retrofitted pulverized coal power plants have achieved outstanding emissions performance for NOx, SOx, and particulates. Similarly, continued advances in the steam cycle continue to provide higher net plant efficiencies. As a result, new pulverized coal-fired power plants are now commercially available with minimal emissions and with very favorable total production cost. Repowering of an old existing coal-fired power plant with a single modern generating unit equipped with commercially proven emissions controls results in significant reductions in total tons of emissions, even while substantially increasing the total megawatt-hour output of the facility. A case study of repowering an actual old coal-fired plant with a unit utilizing current technology showed a 32% higher design capacity, achieving triple the total electrical output, an 87% reduction in tons of NOx and SOx up the stack, and a 42% reduction in total electricity production costs.

**Pulverized Coal Technology Options**

The configuration of today's state-of-the-art pulverized coal power plant is primarily dependent on the sulfur quantity of the coal to be utilized.

Low sulfur coals will most economically utilize a dry scrubber and baghouse for $SO_2$ and particulate control. Wet scrubbers can also be utilized with the benefit of producing a useful byproduct (gypsum).

Higher sulfur coals will utilize a wet scrubber and precipitator or baghouse for $SO_2$ and particulate control.

NOx emissions will be controlled by both Low NOx Burners (LNB )and Selective Catalytic Reduction (SCR).

The boiler/turbine steam cycle will vary from a standard subcritical cycle to an advanced supercritical cycle depending on project requirements and fuel costs.

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