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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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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

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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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, <u>and includes, but is not limited to, incinerators and waste-to-energy facilities that burn municipal solid waste,</u> . . .

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 <u>excludes</u> "materials diverted or removed for purposes of energy recovery <u>or</u> combustion []" from being considered recovered material.

Assuming, for the sake of argument, that the waste <u>were</u> 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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