



Utilis
Energy

Coal Gasification 2006

Roadmap to commercialization

'We are developing important bridge technologies such as coal gasification'

Samuel W. Bodman – Secretary of Energy, United States of America

Reference Code: UE CG/06

Publication Date: 5/23/06

Order Form After Page 11



ABOUT UTILIS ENERGY

ABOUT UTILIS ENERGY

[Utilis Energy](#) is a new kind of research firm.

With offices in North America and Europe, we specialize in providing the global energy industry with market research of unparalleled quality.

The Utilis team is comprised of highly qualified professionals, all of whom have developed their expertise through years of experience in the energy sector.

Our mission...

Our mission, simply stated, is to help our clients make better-informed business decisions.

We provide our clients with:

- Timely industry information and analysis
- Unmatched insight from energy specialists
- Client focused support structure

Please contact us to discuss your information and research needs

All Rights Reserved.

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher, Utilis Energy LLC.

The facts of this report are believed to be correct at the time of publication but cannot be guaranteed. Please note that the findings, conclusions and recommendations that Utilis Energy delivers will be based on information gathered in good faith from both primary and secondary sources, whose accuracy we are not always in a position to guarantee. As such Utilis Energy can accept no liability whatever for actions taken based on any information that may subsequently prove to be incorrect.

CONTENTS

TABLE OF CONTENTS

Summary & Overview	9
Introduction	12
Overview	12
History	13
Market applications	25
Gasification technologies	26
Conclusions	29
Gasification Economics and the Environment	30
Introduction	30
Cost comparision	30
Efficiency benefits	31
Emissions	33
Conclusions	35
Development Issues and recent News	37
Introduction	37
Challenges to development	41
Recent coal gasification commercialization developments	43

CONTENTS

Conclusions	49
Gasification Case Studies	50
Introduction	50
Eastman Chemical Company's coal gasification plant	50
Tampa Electric's Polk Power Station	51
Global Energy / PSI Energy Wabash River	53
Dakota Gasification Company	56
NUON - Buggenum	57
Elcogas - Puertollano	58
Sarlux	58
Nippon Petroleum Refining Corporation	59
Unsuccessful project - Piñon Pine IGCC Power Project (Sierra Pacific)	59
Conclusions	61
Outlook for continued growth	62
DOE selections	63
Other DOE IGCC sponsorship	64
Conclusions	67
Conclusions and Recommendations	69
Market penetration strategies	70



CONTENTS

Recommendations	72
Appendix 1	75
Proprietary gasification technologies	75

CONTENTS

TABLES

Table 1:	Top gasification projects by syngas output (a)	17
Table 2:	Top gasification projects by syngas output (b)	18
Table 3:	Top gasification projects by syngas output (c)	19
Table 4:	Gasification plants started 2000 - 2004	20
Table 5:	Gasification plants planned 2005-2010 (a)	21
Table 6:	Gasification plants planned 2005-2010 (b)	22
Table 7:	Gasification plants planned 2005-2010 (c)	23
Table 8:	US gasification projects under development	24
Table 9:	IGCC, coal, gas cost comparison	31
Table 10:	Cost of electricity comparison (\$/MWh)	31
Table 11:	Technology efficiency levels	33
Table 12:	Plant emissions comparison, SCPC vs. IGCC	33
Table 13:	Emissions by gasification process	34
Table 14:	Wabash River IGCC production statistics	54
Table 15:	Wabash thermal performance summary	54

FIGURES

Figure 1:	Potential gasification applications	12
Figure 2:	Gasification process schematic	13

CONTENTS

Figure 3:	World gasification capacity by technology, 2004	16
Figure 4:	Worldwide gasification capacity and growth, 1970-2010	21
Figure 5:	Moving bed gasifier	27
Figure 6:	Fluidized gasifier	28
Figure 7:	Entrained gasifier	29
Figure 8:	Cost of mercury removal (\$/lb mercury removed)	35
Figure 9:	IGCC vs. Fluidized Bed using petroleum coke	36
Figure 10:	Eastman's coal gasification process	51
Figure 11:	Tampa Electric Polk Station	52
Figure 12:	Wabash River - IGCC schematic	55
Figure 13:	Piñon Pine gasification facility	60
Figure 14:	FutureGen Project - scale model	65
Figure 15:	FutureGen Project - timeline, components and estimated costs	67
Figure 16:	Texaco Entrained Flow (downflow) gasifier	76
Figure 17:	E-GAS Entrained Flow (upflow) gasifier	77
Figure 18:	Shell Entrained Flow (upflow) gasifier	79
Figure 19:	KRW Fluidized - Bed gasifier	81
Figure 20:	Kellogg Transport Reactor gasifier	82
Figure 21:	Lurgi Dry Ash gasifier	84
Figure 22:	British Gas/Lurgi Fixed-Bed gasifier	85

CONTENTS

Figure 23: Future Energy Entrained Flow gasifier	87
Figure 24: Prenflo Entrained Bed gasifier	88

SUMMARY & OVERVIEW

SUMMARY & OVERVIEW

Coal gasification offers one of the most clean and versatile ways to convert the energy contained in coal into electricity, hydrogen, and other sources of power. Turning coal into synthetic gas isn't a new concept, in fact the basic technology dates back to World War II.

During the gasification process, coal is subjected to heat, pressure, and steam - catalysts, breaking the coal down into various gases, mostly hydrogen. The resulting gases can then be burned to generate electricity and the waste heat created by the process used for cogeneration.

Coal gasification plants are cleaner than standard pulverized coal combustion facilities, producing fewer sulfur and nitrogen byproducts, which contribute to smog and acid rain. For this reason, gasification appeals as a way to utilize relatively inexpensive and expansive coal reserves, while reducing the environment impact.

Pioneering coal gasification electric power plants are now operating commercially in the United States and in other nations. These plants produce significant quantities of syngas from a variety of feedstocks and produce a wide variety of products.

The mounting interest in coal gasification technology reflects a convergence of three changes in the electricity generation marketplace. These changes are:

1. The increasing maturity of gasification technology;
2. The extremely low emissions from Integrated Gasification Combined Cycle (IGCC) plants, especially air emissions, and the potential for lower cost control of greenhouse gases than other coal-based systems; and
3. The recent dramatic fluctuations in the costs associated with natural gas based power, which is viewed as a major competitor to coal based power.

While the benefits of IGCC have been demonstrated by many public and private projects, there remain significant barriers to further market penetration of this technology, including:

- Price - the technology is around 20% more expensive than competing alternatives; and
- Technology risk - many of the existing systems don't have long-term operating histories.



SUMMARY & OVERVIEW

Even with these barriers, interest in coal gasification is at an all-time high in the US because the process has the potential to support a sizeable share of America's future energy needs in an environmentally responsible way.

Gasification permits the utilization of US coal supplies to their fullest potential and the US has more coal than any other country in the world with estimated recoverable reserves of 275 billion tons. This represents approximately 25% of world supply and more than 250 years of supply for domestic consumption. This share of world coal reserves is in sharp contrast to the US share of global oil and natural gas reserves, which are estimated to be less than 2% and 3% respectively.

Power developers, currently faced with rising natural gas prices, increasingly restrictive emissions requirements, and a desire for fuel diversification, are re-examining their power generation portfolios and are looking toward clean coal technologies as a means to alleviate these concerns by producing electricity using US domestic coal resources.

The Clean Coal Power Initiative

To develop new energy technologies, the Bush Administration introduced the Clean Coal Power Initiative (CCPI) in 2002. CCPI is a technology demonstration program that fosters the efficient use of clean coal technologies in new and existing electric power generating facilities in the US. The program provides a forum for the testing of these new technologies prior to full-scale commercialization.

Early CCPI demonstrations focused on technologies that apply to existing power plants and construction of new plants. Later demonstrations are expected to include systems comprising advanced turbines, membranes, fuel cells, gasification processes, hydrogen production, and other technologies.

President Bush's US energy program calls for an additional \$2 billion in funding over the next decade for another round of the government's 20 year old Clean Coal Technology Program. This funding is particularly important when one considers that greater than half of the over 1,000 US coal-fired power plants are more than 30 years old and will require replacement over the next 20 years.

The DOE has provided funding for coal gasification projects that have operated successfully for years in Florida and Indiana and have demonstrated the commercial viability of this technology. At the end of 2004 the DOE granted funding for two additional IGCC projects, in Florida and

SUMMARY & OVERVIEW

Minnesota, both of which are expected to further advance industry acceptance of the technology and illustrate its viability.

During President Bush's second term, coal is expected to play a key role in US energy policy. In August 2005, President Bush signed the Energy Policy Act into law. The Act contains significant incentives to support gasification technology research and development and to accelerate commercial deployment of gasification technologies for both power generation and industrial use. The primary incentives for this development include:

- Cost share programs (up to 50% direct grants);
- Investment tax credits (20% of project cost); and
- Federal loan guarantees (up to 80% of project costs) that in some cases (specifically tax credits and loan guarantees) can be used in combination.

Additional financial support for IGCC development came from the Bush Administration's 2006 DOE budget that provides \$56.45 million for IGCC research and development, an increase of 23% over the prior fiscal year. In addition, with the President's 'Clear Skies' Initiative requiring 70% reductions of many emissions by 2018, a market for utilizing clean coal technologies over the long term is likely to evolve.

Coal Gasification 2006: Roadmap to commercialization provides an introduction to coal gasification technology and its ability to unlock the huge energy reserves found in coal in an environmentally responsible manner. Working gasification projects in the private and public sector are discussed and recommendations are offered to provide a "roadmap" for the continued successful commercialization of this technology.

Report Fax Order Form

I would like to purchase ____ copy(ies) of ***Coal Gasification 2006: Roadmap to Commercialization*** at \$495 per copy.

(Please indicate whether you would like a "printable pdf" or "hard copy" of the publication as appropriate)

Electronic delivery ("printable" pdf) Hard copy

*Please add \$50 domestic
or \$70 international to
cover hard copy shipping*

Corporate license available for US\$995 Please call for more details

TOTAL TO BE BILLED TO CREDIT CARD :US\$ _____

Purchaser Information:

Name: _____ Title: _____

Company: _____

Address: _____ tel: _____

_____ email: _____

_____ fax: _____

Signature: _____

Credit Card (Visa / MC): Number: _____

Exp. _____

Please fax this form to the Power Marketing Association at
201.767.1928 or to order a "printable pdf" online now [click here](#)