By most estimates, global consumption of natural gas – a cleaner-burning alternative to coal and oil for electric power and other applications – will double by 2030. However, in North America, Europe, and South and East Asia, the projected consumption of gas is expected to far outstrip indigenous supplies. Delivering gas from the world’s major reserves to the future demand centers will require a major expansion of inter-regional, cross-border gas transport infrastructures.

This book investigates the implications of this shift, utilizing historical case studies as well as advanced economic modeling to examine the interplay between economic and political factors in the development of natural gas resources. The contributors aim to shed light on the political challenges which may accompany a shift to a gas-fed world.

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Natural Gas and Geopolitics

*From 1970 to 2040*

Edited by

David G. Victor, Amy M. Jaffe, and Mark H. Hayes
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Foreword

James A. Baker, III

The publication of *Natural Gas and Geopolitics: From 1970 to 2040* could not be timelier. The sharp rise of oil and gas prices that began in 2003 has returned energy to the top of the US public policy agenda. We have been reminded, yet again, of the centrality of energy to our and the world’s economic well-being. Discussion has now turned to the domestic policies and international initiatives that can help ensure a stable, reasonably priced supply of energy to global markets through the middle of the twenty-first century and beyond.

One thing is certain: natural gas will play a critical role in meeting the world’s energy needs. A series of important economic, political, and technological factors – the growing global demand for energy, the ongoing deregulation of gas and electrical markets, a preference for gas as the cleanest of the hydrocarbons, and declines in the cost of producing and transporting liquefied natural gas (LNG) – have laid the groundwork for an expanded role for natural gas in the world economy.

But there are a host of obstacles to seizing the full potential of natural gas. While increased trade in LNG opens up the possibility of a truly global market for gas, the pace and ultimate scope of this historic development remains very much in doubt. The shift from governments to the private sector as lead players in major pipeline and LNG projects, though welcome, raises important questions of investor confidence, regulatory environment, political risk, and competition from other hydrocarbon fuels and renewable energy sources. The amount of private investment required – by some estimates, up to 3 trillion dollars over the next quarter-century – is simply immense. Any number of factors – from the threat of terrorism to a retreat from market liberalization – could make raising these sums problematic.

The rise of natural gas also poses thorny geopolitical questions. The lion’s share of proven gas reserves are found in areas, like the Middle East and the countries of the former Soviet Union, characterized by regional tensions and political instability. The concentration of these reserves in a relatively few countries raises, at least in theory, the possibility of a producers’ cartel or “gas OPEC.” These are issues that US policy-makers cannot afford to ignore. Long largely self-sufficient in natural gas, the United States will be increasingly dependent on imports during the years and decades ahead.

Natural Gas and Geopolitics: From 1970 to 2040 marks an important step in addressing these and other crucial issues. It is the result of a multi-year study organized by Rice University’s James A. Baker III Institute for Public Policy and Stanford University’s Program on Energy and Sustainable Development. The study assembled a team of prominent economists, political scientists, and energy experts from the United States and around the world to address the future of natural gas. Their impressive work includes case studies, economic models, and analytic essays.

I would like to commend editors David G. Victor, Amy M. Jaffe, and Mark H. Hayes for organizing the study and producing this invaluable volume. The national and international debate over the role of natural gas in the global economy is in many ways still in its infancy. Natural Gas and Geopolitics: From 1970 to 2040 will provide an insightful and comprehensive introduction to these issues for policy-makers, scholars, industry executives, and concerned citizens alike.
Acknowledgments

In 2002, the Energy Forum of the James A. Baker III Institute for Public Policy at Rice University and the Program on Energy and Sustainable Development at the Freeman Spogli Institute for International Studies, Stanford University, began a joint effort to investigate the geopolitical consequences of a major shift to natural gas in world energy markets. We are grateful to our many collaborators and funders for their interest in the long-term evolution of this important industry, its consequences for the economy and environment, and implications for politics and policy.

The Baker Institute Energy Forum thanks project sponsors Baker Botts LLP and Ambassador and Mrs. Hushang Ansary for their generous support of this research. In addition, the Institute thanks its Energy Forum members for their ongoing support and advice for this project. The Program on Energy and Sustainable Development is grateful for core funding from the Electric Power Research Institute and BP plc, which made its participation in this study possible.

We thank the many collaborators and reviewers who have participated in the study. The collaborative research began in earnest at an October 2002 kickoff meeting at Stanford, and we thank the participants for their focused critique of our research plans and methods.

We commissioned several historical case studies, and in November 2003 at Stanford the authors presented drafts for review. (The final versions of these studies are in chapters 3–9 of this book, with more detailed working papers on our websites–http://pesd.stanford.edu and http://rice.edu/energy.) In parallel, the Rice modeling team developed a model to allow projections of gas trade into the future, and initial results were presented at a review meeting in Houston in March 2004. We are enormously grateful to the several dozen participants and reviewers at those two meetings.

We would also like to thank Altos Management Partners for the donation of their software platform Marketbuilder for use during this study and to Hill Huntington and the US Department of Energy for their comments and critique of the model through Stanford's Energy...
Modeling Forum and during private sessions over the study period. (Final versions of those studies are in chapters 11–13, along with online working papers.)

In May 2004 we convened a major conference in Houston to present the initial findings from the study. We are especially grateful to the many speakers and panelists and especially Baker Botts LLP and Shell Exploration & Production Company that, along with our core funders, made that meeting possible. We would like to thank our conference keynote speakers: the Honorable James A. Baker, III, Baker Institute Honorary Chair; Philip Dingle, President, ExxonMobil Gas and Power Marketing Company; Ambassador Edward Djerejian, Baker Institute director; H.E. Abdullah bin Hamad Al-Attiyah, Minister of Energy and Industry of Qatar; Peter Hughes, Executive Vice President, Group Strategy, BG Group plc (then with BP plc); H.E. Dr. Chakib Khelil, Minister of Energy and Mines, People’s Democratic Republic of Algeria; Tomiyuki Kudo, President, Petroleum Energy Center of Japan; James Mulva, President and CEO of ConocoPhillips; and Congressman Francisco Xavier Salazar Diez Sollano, Chairman, Energy Commission, Mexican Chamber of Deputies, for taking the time to share their unique insights on the geopolitics of natural gas. We would especially like to thank Molly Hipp, Sonja Dimitrijevich, Ryan Kirksey and Jason Lyons at the Baker Institute for organizing a seamless event, along with Jack Hogan, Ale Núñez-Luna, and Kassia Yanosek who traveled from Stanford to provide critical support.

In addition to the capstone conference in Houston, we have benefited from comments at various seminars where we have presented the study findings. These include seminars at UC Berkeley, the Graduate School of Business at Stanford, and also Stanford’s Center for Development, Democracy, and the Rule of Law.

We owe particular gratitude to George H.B. Verberg, President of the International Gas Union and Bert Panman, Chairman of the IGU Coordination Committee for providing our research a prestigious position at the 23rd World Gas Conference in June 2006.

The breadth and depth of this volume is a product of the extensive contributions of our co-authors. Our conclusions rest upon their in-depth research. Their patience with our lengthy review process is duly appreciated.

This manuscript would not have reached publication were it not for the countless hours of support from the staffs at our respective institutions and the work of our editors at Cambridge University Press. At Stanford—Becca Elias, Josh House, Rose Kontak, Michelle Klippel, and Bob Sherman provided critical support, especially in the busiest times;
Meredith Williams and Becca Newton-Thompson, also at Stanford, deserve full credit for the maps included in the case study chapters. At the Baker Institute, Jill Nesbitt, Jillene Connors, Christina Estrada, and Laura Iszar often burned the midnight oil in aid of this massive project. Our editors at Cambridge, Chris Harrison, Lynn Dunlop, and Elizabeth Davey, and our copy-editor Barbara Docherty, were a pleasure to work with throughout the publication process.

Finally, we thank our family and friends, who supported us through the many evenings and weekends leading up to the production of this effort.

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Acronyms and abbreviations

ADB  Asian Development Bank
ADR  American Depositary Receipts
Agip  Italy's state oil company
AIC  Association of International Cooperation (Russia)
ALADI  Asociación Latinoamericana de Integración
ALNG  Atlantic LNG
AP  alternative project
APCI  Air Products & Chemicals, Inc., with trademark process for natural gas liquefaction
APERC  Asia Pacific Energy Research Center
Apicorp  Arab Petroleum Investments Corporation
ASEAN  Association of Southeast Asian States
BBE  Bahia de Bizkaia Electricidad
BC  Belarus Connector
Bcf/d  billion cubic feet per day
Bcm  billion cubic meters
b/d  barrels (of oil) per day
BIWGTMM  Baker Institute World Gas Trade Model
BNDES  Brazilian National Development Bank
Botas  Turkey’s monopoly gas importer
BTC  Baku–Tbilisi–Ceyhan (oil pipeline)
BTE  Baku–Tbilisi–Erzurum (gas pipeline)
Bu  British thermal unit
Btu/cm  British thermal unit/cubic meter
CAC  Central-Asia-Center (Turkmen–Russia gas pipeline)
CAF  Corporación Andina de Fomento, Andean Development Corporation
CAMEL  Compagnie Algérienne de Méthane Liquide
CBM  coal-bed methane
CCGT  combined cycle gas turbine
CEE  Central and Eastern European
CEO  chief executive officer

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List of acronyms and abbreviations

CEPSA Compañía Española de Petróleos SA
CGG Compañía General de Combustibles SA (Argentina)
c.i.f. cost-insurance-freight
CIPE Center for International Private Enterprise
CIS Commonwealth of Independent States
CMEA Council for Mutual Economic Assistance (COMECON)
CNG compressed natural gas
CNOOC China National Offshore Oil Corp.
COMECON see CMEA
Copec Compañía de Petroleos de Chile
CPI Consumer Price Index (US)
d.e.s. destination ex-ship
EBRD European Bank for Reconstruction and Development
EC European Community
ECAFE UN Economic Commission for Asia and the Far East
   (later ESCAP)
ECE United Nations Economic Commission for Europe
ECO Economic Cooperation Organization
EEC European Economic Community
EFTA European Free Trade Association
EGU Enhanced Gas Utility (Qatar)
EIA Energy Information Administration (US)
EIB European Investment Bank
EIU Economist Intelligence Unit
ENAP Empresa Nacional de Petroleo, Chile’s national oil company
ENI Ente Nazionale Idrocarburi (National Hydrocarbon Corporation, Italy)
EPC engineering, procurement, construction
ESCAP UN Economic and Social Commission for Asia and the Pacific
EU European Union
FBIS Foreign Broadcast Information Service
FDI foreign direct investment
FEED front-end engineering and design
FID final investment decision
FIESP Federação das Indústrias de Estado de São Paulo
FLN Front de Libération Nationale (Algeria)
f.o.b. freight-on-board
FSU Former Soviet Union
Gasbol Bolivia–Brazil gas pipeline
List of acronyms and abbreviations

GCC Gulf Cooperation Council
GCV Gross Calorific Value
GdF Gaz de France
GDP gross domestic product
GECF Gas Exporting Countries Forum
GIRI General Investment Risk Index
GLS generalized least squares
GME Gaz Maghreb Europe (“Maghreb pipeline”)
GTB Gas Transboliviano SA
GTL gas-to-liquids
GW gigawatt
ha hectare
HHV high heating value
IADB Inter-American Development Bank
ICC International Chamber of Commerce
ICJ International Court of Justice
ICRG International Country Risk Guide
ICSID International Center for the Settlement of Investment Disputes
IEA International Energy Agency (Paris)
IFC International Finance Corporation (part of the World Bank)
IGCC Integrated gasification combined cycle
ILSA Iran and Libya Sanctions Act
IMF International Monetary Fund
IOC international oil company
IRNA Islamic Republic News Agency (Iran)
ISOCOTT Iron and Steel Company of Trinidad & Tobago
IV independent variable – investment climate, number of transit countries for a particular gas trade project, etc.
JCC Japanese Customs Clearing Price, often referred to as the “Japanese Crude Cocktail”
JCCME Japan Cooperation Center for Middle East
J-EXIM Export–Import Bank of Japan (now Japan Bank for International Cooperation, JBIC)
JILCO Japan Indonesia LNG Company
JMG Joint Management Group (Indonesia)
JNOC Japan National Oil Corporation
JV joint venture
JVA joint-venture agreement
kj/cm kilojoules/cubic meter
km kilometer
List of acronyms and abbreviations

KOGAS  Korea Gas Corporation
KWh  kilowatt hours
LHV  low heating value
LIBOR  London Interbank Offered Rate
LNG  liquefied natural gas
LPG  liquid petroleum gas
m  meter
Maphilindo  Malaysia, the Philippines, Indonesia
MarAd  Maritime Administration (US)
MBOE  million barrels of oil equivalent
mcm  thousand cubic meters
Mercosur  Mercado Común del Sur, Southern Common Market
METI  Ministry of Economy, Trade, and Industry (Japan)
MFN  most-favored nation
MITI  Ministry of International Trade and Industry (Japan), now METI
MLA  multi-lateral lending agency
mm  millimeter
mmBtu  million British thermal units
mmHg  mm of mercury (measure of pressure)
MNC  multi-national corporation
MNR  Movimiento Nacionalista Revolucionario (Bolivia)
MOU  memorandum of understanding
Mtoe  million tonnes of oil equivalent
mtpa  million tonnes per annum
MW  megawatt
NAFTA  North American Free Trade Agreement
NAR  National Alliance for Reconstruction (Trinidad & Tobago)
NATO  North Atlantic Treaty Organization
NCV  Net Calorific Value
NEGP  North European Gas Pipeline
NGC  National Gas Company (Trinidad & Tobago)
NGLs  natural gas liquids
NGO  non-governmental organization
NIGC  National Iranian Gas Company
NIOC  National Iranian Oil Company
NLNG  Nigeria LNG
NNPC  Nigerian National Petroleum Company
NPC  National Petroleum Council (US)
NPV  net present value
NYMEX  New York Mercantile Exchange
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<td>O&amp;M</td>
<td>operating and maintenance (costs)</td>
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<td>OAS</td>
<td>Organization of American States</td>
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<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
</tr>
<tr>
<td>OPEC</td>
<td>Organization of Petroleum Exporting Countries</td>
</tr>
<tr>
<td>OPIC</td>
<td>Overseas Private Investment Corporation (US)</td>
</tr>
<tr>
<td>PDVSA</td>
<td>Petróleos de Venezuela SA., Venezuela’s national oil company</td>
</tr>
<tr>
<td>PESD</td>
<td>Program on Energy and Sustainable Development (Stanford University)</td>
</tr>
<tr>
<td>PG&amp;E</td>
<td>Pacific Gas and Electric Company (US)</td>
</tr>
<tr>
<td>PGNiG</td>
<td>Polskie Górnictwo Naftowe Gazownictwo, Polish Oil and Gas Company</td>
</tr>
<tr>
<td>PNM</td>
<td>People’s National Movement (Trinidad &amp; Tobago)</td>
</tr>
<tr>
<td>PSA</td>
<td>production-sharing agreement</td>
</tr>
<tr>
<td>PSC</td>
<td>production-sharing contract</td>
</tr>
<tr>
<td>PV</td>
<td>present value</td>
</tr>
<tr>
<td>QP</td>
<td>Qatar Petroleum (formerly Qatar General Petroleum Company, QGPC)</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>research and development</td>
</tr>
<tr>
<td>ROE</td>
<td>return on equity</td>
</tr>
<tr>
<td>SADC</td>
<td>Southern African Development Community</td>
</tr>
<tr>
<td>SADR</td>
<td>Saharan Arab Democratic Republic</td>
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<tr>
<td>SAP</td>
<td>structural adjustment program</td>
</tr>
<tr>
<td>SCC</td>
<td>specific capital cost</td>
</tr>
<tr>
<td>SCOGAT</td>
<td>Société pour la Construction du Gazoduc Transtunisien (Tunisia)</td>
</tr>
<tr>
<td>Segamo</td>
<td>Sociedad de Estudios Gasducto del Mediterráneo Occidental (Spain)</td>
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<tr>
<td>SNOC</td>
<td>Singapore National Oil Company</td>
</tr>
<tr>
<td>SOE</td>
<td>state-owned enterprise</td>
</tr>
<tr>
<td>Sonatrach</td>
<td>Société Nationale pour le Transport et la Commercialisation des Hydrocarbures (Algeria)</td>
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<tr>
<td>SOTUGAT</td>
<td>Société du Gazoduc Transtunisien (Tunisia)</td>
</tr>
<tr>
<td>SPA</td>
<td>sales and purchase agreement</td>
</tr>
<tr>
<td>TBG</td>
<td>Transportadora Brasileira Gasoduto Bolivia–Brazil SA</td>
</tr>
<tr>
<td>Tcm</td>
<td>trillion cubic meters</td>
</tr>
<tr>
<td>TCO</td>
<td>Transport Capacity Option</td>
</tr>
<tr>
<td>TCP</td>
<td>Trans-Caucasian Pipelne</td>
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<tr>
<td>TCQ</td>
<td>Transport Contract Quantity</td>
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<tr>
<td>TGN</td>
<td>Transportadora Gas del Norte (Argentina)</td>
</tr>
<tr>
<td>TJ</td>
<td>Terajoules</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>TMPC</td>
<td>Trans-Mediterranean Pipeline Company Limited</td>
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<tr>
<td>TRINGENI</td>
<td>Trinidad &amp; Tobago Nitrogen Company</td>
</tr>
<tr>
<td>TSKJ</td>
<td>Consortium of Technip, Kellogg, Snamprogetti, and JGC</td>
</tr>
<tr>
<td>TTMC</td>
<td>Trinidad &amp; Tobago Methanol Company</td>
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<tr>
<td>TTP</td>
<td>Turkmenistan Transcontinental Pipeline</td>
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<tr>
<td>TTPC</td>
<td>Trans-Tunisian Pipeline Company Limited</td>
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<tr>
<td>TTUC</td>
<td>Trinidad and Tobago Urea Company</td>
</tr>
<tr>
<td>UAE</td>
<td>United Arab Emirates</td>
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<tr>
<td>UES</td>
<td>United Energy System (Russian state electric power enterprise)</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNC</td>
<td>United National Company (Trinidad &amp; Tobago)</td>
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<tr>
<td>UOG</td>
<td>UAE Offsets Group</td>
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<tr>
<td>USD</td>
<td>US dollar</td>
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<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
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<tr>
<td>USSR</td>
<td>Union of Soviet Socialist Republics, Soviet Union</td>
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<tr>
<td>VALHYD</td>
<td>Hydrocarbon Development Plan of Algeria</td>
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<tr>
<td>VAT</td>
<td>value added tax</td>
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<tr>
<td>VNG</td>
<td>East German gas transmission company</td>
</tr>
<tr>
<td>WACC</td>
<td>weighted average cost of capital</td>
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<tr>
<td>WEC</td>
<td>World Energy Council</td>
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<tr>
<td>WIEE</td>
<td>Wintershall Erdgas Handelshaus Zug AG</td>
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<tr>
<td>WIEH</td>
<td>Wintershall Erdgas Handelshaus GmbH</td>
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<tr>
<td>YABOG</td>
<td>Bolivia–Argentina gas pipeline</td>
</tr>
<tr>
<td>YPF</td>
<td>Yacimientos Petrolíferos Federales (Argentine gas consortium)</td>
</tr>
<tr>
<td>YPFB</td>
<td>Yacimientos Petrolíferos Fiscales de Bolivia, Bolivian national oil company</td>
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