

CASE NOS. PU-06-481 & PU-06-482
BEFORE THE NORTH DAKOTA PUBLIC SERVICE COMMISSION
IN THE MATTER OF THE APPLICATION BY OTTER TAIL POWER CORPORATION D/B/A
OTTER TAIL POWER COMPANY
AND
MONTANA-DAKOTA UTILITIES CO., A DIVISION OF MDU RESOURCES GROUP, INC.
FOR AN ADVANCED DETERMINATION OF PRUDENCE
FOR THE BIG STONE II GENERATING PLANT

PREFILED REBUTTAL TESTIMONY

OF

DANIEL KLEIN

PRESIDENT

TWENTY-FIRST STRATEGIES, LLC

APRIL 23, 2008



PREFILED REBUTTAL TESTIMONY OF DANIEL KLEIN

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1 **BEFORE THE NORTH DAKOTA PUBLIC SERVICE COMMISSION**

2 **PREFILED REBUTTAL TESTIMONY OF DANIEL KLEIN**

3 **I. INTRODUCTION**

4 **Q: Please state your name and business address.**

5 A: My name is Daniel E. Klein, and my business address is Twenty-First Strategies, LLC,
6 6595 Terri Knoll Court, McLean, VA 22101.

7 **Q: By whom are you employed, and in what capacity?**

8 A: I am President of Twenty-First Strategies, LLC, a consulting firm founded in 1995 to
9 offer energy and environmental consulting services to electric power companies, industry
10 associations, government agencies, NGOs, and others

11 **Q: What is your educational background?**

12 A: In 1973, I received a bachelor's degree in Urban Studies from the Massachusetts Institute
13 of Technology. In 1975, I received a Masters of Business Administration from the Stanford
14 University Graduate School of Business.

15 **Q: What is your employment history?**

16 A: In the 30-plus years since I completed my graduate studies, I have been a consultant
17 specializing in energy, environmental, and economic analysis. Beginning in 1975, I was
18 employed for over twenty years by the consulting firm ICF Resources Incorporated (originally
19 ICF Inc.), where for several years I was a Senior Vice President and Director. I founded Twenty-
20 First Strategies in 1995 to offer energy and environmental consulting services to electric power
21 companies, industry associations, government agencies, NGOs, and others.

1 Over the course of my consulting career, I have conducted hundreds of projects related to
 2 energy and environmental concerns, energy markets, electric utility fuel use, coal supply,
 3 transportation, and antitrust issues. My work in recent years has focused primarily on energy,
 4 climate change, and related issues, both on policy issues from the government side as well as
 5 strategies for the private sector.

6 Attached as OTP/MDU Exhibit 349 to this Testimony is my resume, which presents my
 7 qualifications and experience in greater detail.

8 **Q: Did you previously submit testimony in this proceeding?**

9 A: This is my first testimony before the North Dakota Public Service Commission.
 10 However, related to the Big Stone II project, I submitted testimony before both South Dakota
 11 and Minnesota public utility commissions.

12 **II. PURPOSE AND SUMMARY OF TESTIMONY**

13 **Q: What is the purpose of your testimony today?**

14 A: My testimony relates to the supplemental direct testimony of David A. Schlissel of
 15 Synapse Energy Economics, Inc., on behalf of Mark Trechock and Dakota Resource Council,
 16 filed on April 9, 2008. Mr. Schlissel has suggested that as an alternative to Big Stone II, a
 17 combination of new natural gas capacity, renewable resources, and energy efficiency could
 18 possibly present a less expensive and lower risk option (Schlissel, pp. 4-5). While he agrees that
 19 “over-reliance on natural gas can be a concern” (Schlissel, p. 8), he does not see this as a
 20 problem of particular concern “in this specific instance and in this specific area of the nation.”

21 In this testimony, I address the following points:

- 1 • If Big Stone II is not built, an alternative means of acquiring baseload resources will be
2 required. Likely alternatives to supply 500 MW of baseload power are few, and increased
3 natural gas generation would be a probable result, either as a primary or backup fuel supply, or
4 as power purchased from the pool.
- 5 • Natural gas (and petroleum) prices are much more volatile than coal prices. Because of
6 this, regions with more coal-fired power in their generation mix tend to have more stable power
7 rates.
- 8 • Natural gas markets are increasingly becoming international, and increasingly subject to
9 many of the same types of price spikes and volatility as seen with petroleum.
- 10 • While CO₂ requirements and/or pricing would affect the costs of using coal at Big Stone
11 II, it would also affect the costs of using natural gas. Gas costs would be affected both by the
12 direct effect of CO₂ pricing on natural gas' CO₂ emissions, and also by the potential rise in
13 market price and volatility for the fuel.
- 14 • The volatility of natural gas prices creates a highly significant risk factor for an electric
15 generation resource that relies on natural gas. If Big Stone II were replaced with gas-fired
16 capacity, an increase in gas prices of only \$1/MMBtu would increase generation costs by as
17 much as \$28,000,000 in a single year.
- 18 • North Dakota's participation in the Midwest ISO exposes it to a natural gas price
19 volatility risk that is much larger than its actual percentage of generation.
- 20 • North Dakota households are at greater risk from natural gas price spikes than most other
21 states. Non-electric residential energy uses in North Dakota indicate higher than average natural
22 gas and petroleum consumption, even while household income is lower than average.

1 Accordingly, if natural gas supplies are constrained in supply and/or subjected to price spikes,
 2 residences can be hit twice – once in their direct consumption of fuel, and again in their use of
 3 natural gas-fueled electricity.

4 **III. NATURAL GAS AS A LIKELY ALTERNATIVE TO BIG STONE II**

5 **Q: Is increased natural gas use a likely alternative if Big Stone II is not built?**

6 A: Yes. As I understand it, the Big Stone II owners have determined there is a need for
 7 baseload resources. Big Stone II has been proposed to meet this increasing demand, and would
 8 be a 500-megawatt (MW), coal-fired electric generation plant. The plant’s dispatchable, baseload
 9 power would increase reliability in the region, as well as add diversity and reduce single-outage
 10 risks for the participants.

11 If Big Stone II is not built, an alternative means of acquiring baseload resources will be
 12 required. Likely alternatives to supply 500 MW of baseload power are few, and would likely
 13 entail dependence upon expensive and risky supplies of natural gas and/or petroleum fuels. In
 14 most parts of the U.S., the primary alternative to a new coal-fired plant would be construction of
 15 a large combined cycle natural gas plant. While nuclear energy is edging closer to again
 16 becoming a viable option for new capacity, it cannot yet be considered “available” with respect
 17 to licensing, timing, and costs. The other primary source of baseload power, large hydroelectric
 18 plants, offers no reasonable opportunities for large-scale additions.

19 In theory, renewable resources such as wind power could substitute for some of the
 20 generation that Big Stone II would produce. But because these resources are intermittent and not
 21 dispatchable, they make only a limited contribution to meeting peak load capacity needs. These
 22 intermittent renewable resources would require back-up capabilities such as natural gas-fired

1 turbines before most of the capacity could be considered dependable. And, because wind power
2 has a capacity factor of about 30% to 40%, some other resource would be needed to provide
3 energy during the other 60% to 70% of the time.

4 Energy efficiency measures and demand-side management measures may also have
5 potential to substitute for some of the needed generation. However, DSM is typically most cost-
6 effective when peak loads are reduced, lessening the need for building additional peak load
7 capacity. Further, because of the low load factors, the energy savings tend to be relatively low
8 relative to capacity savings. These savings are less applicable to a baseload project such as Big
9 Stone II.

10 Accordingly, capacity alternatives to Big Stone II entail utilization of natural gas (or
11 petroleum fuels), either as a primary or backup fuel supply. If this capacity is not built and
12 operated by these utilities, it will most likely be in the form of natural gas-fired power purchased
13 from the pool instead.

14 **IV. GREATER VOLATILITY OF NATURAL GAS PRICES**

15 **Q: Why is fuel price volatility a concern?**

16 A: Increased reliance on natural gas power entails substantial price and supply availability
17 risks. Oil and natural gas prices have increased sharply in recent years, and now the incremental
18 cost relative to coal is far higher than levels seen in the 1990s. We are also observing much
19 greater volatility in oil and natural gas prices, relative to both earlier years and to coal. The
20 inherent volatility in natural gas prices creates a significant risk factor for an electric generation
21 resource that relies on natural gas. Because of this, regions with more coal-fired power in their
22 generation mix usually have more stable electric power rates.

1 **Q: Are coal price risks significant?**

2 A: Fuel prices are a large part of power generation costs. As such, changes in current and
3 projected fuel prices are important considerations. In recent years, coal prices have risen
4 significantly on a percentage basis. However, since the coal prices are so much lower than
5 natural gas prices, this percentage increase is small in absolute terms relative to the changes seen
6 in the highly volatile natural gas market.

7 **Q: How have forecast prices for natural gas changed?**

8 A: Natural gas (and petroleum) prices have increased sharply in recent years, and now the
9 incremental cost relative to coal is far higher than levels seen in the 1990s. Additionally, the
10 outlook for natural gas supplies has been worsening for consumers. In the last few years,
11 available supplies for both natural gas and petroleum fuels have been much tighter, resulting in
12 sharply higher market prices, volatile price patterns, and rapidly increasing expectations for
13 higher prices well into the future.

14 Natural gas prices remain high and volatile. While today's prices have eased off some
15 from their highest prices seen in late 2005, they remain at levels far higher than seen just a few
16 years ago. Since the beginning of 2006, the U.S. average price of natural gas delivered to the
17 electric power sector has ranged between \$5.76 and \$9.15 per thousand cubic feet (mcf).¹ During
18 this brief period there have been at least four months in which the average price rose or fell by
19 over \$1.00 per mcf from the previous month.

20 Longer-term, the price outlook for natural gas consumers continues to worsen. Using the
21 Energy Information Administration's (EIA) *Annual Energy Outlook (AEO)* projections, I

¹ U.S. Department of Energy, Energy Information Administration, *Monthly Energy Review March 2008*,
Table 9.11, "Natural Gas Prices", http://www.eia.doe.gov/emeu/mer/pdf/pages/sec9_17.pdf.

1 compiled a retrospective of several years' worth of natural gas price forecasts that they had made
2 for the years 2010-2020. In MDU/OTP Exhibit 342, I have taken the *AEO* price forecasts for
3 natural gas delivered to the electric power sector in 2010 through 2030. I have done this for 11
4 consecutive *AEO* forecasts, extending back to the 1998 *AEO*. Because the forecasts are presented
5 in different year dollars, I have converted all prices into constant year 2000 dollars, using the
6 GDP Implicit Price Deflator. As MDU/OTP Exhibit 342 shows, eleven years' worth of price
7 forecasts have become year-by-year progressively higher, with future prices now more than half
8 again as pricey as had been expected only a few years ago.

9 **Q: In the forecasts, how does natural gas price volatility compare to that of coal?**

10 A: Natural gas price forecasts show far more price volatility compared to coal. This can be
11 seen by examining the absolute changes in future price projections when the forecasts are
12 updated each year.

13 OTP/MDU Exhibit 343 shows how much more substantial the price changes are for
14 natural gas relative to coal. OTP/MDU Exhibit 343 examines the forecast prices for coal and for
15 natural gas for the forecast years 2010, 2015, and 2020. The price forecasts are drawn from ten
16 years' worth of *AEO* price forecasts, beginning with *AEO 1998* which was the first time 2020
17 forecasts were published. Part A of OTP/MDU Exhibit 343 shows the coal and natural gas price
18 forecasts as they were published in the respective *AEOs*. I have converted here into real 2000\$
19 for comparability; these year 2000\$ prices are shown in Part B of OTP/MDU Exhibit 343. Then,
20 Part C of OTP/MDU Exhibit 343 shows the changes in price forecasts relative to the previous
21 year's *AEO* forecasts.

1 OTP/MDU Exhibit 343 shows dramatically how very much more volatile the price
2 forecasts are for natural gas compared to coal. With three price forecast years (2010, 2015, and
3 2020) and nine sets of AEO forecasts after 1998, there are 27 price forecast changes shown for
4 both coal and natural gas. As can be seen (in Part C of OTP/MDU Exhibit 343), of the 27 coal-
5 related price changes, 19 are less than \$0.10 per MMBtu, and the maximum change is only \$0.18
6 per MMBtu. In sharp contrast, only 7 of the natural gas-related price changes are less than \$0.10
7 per MMBtu, and the maximum change is \$0.98 per MMBtu, over five times that of any of the
8 coal price changes. In fact, of the 14 biggest year-to-year price changes in the table (either up or
9 down), all 14 relate to natural gas.

10 **V. INTERNATIONAL TRENDS IN NATURAL GAS SUPPLY AND PRICING**

11 **Q: How do international trends affect natural gas supply availability and prices?**

12 A: For many years, the U.S. viewed natural gas mainly as a domestic fuel, insulated from
13 world pressures. For much of the world, that is already no longer the case. For the U.S., those
14 days are rapidly coming to a close. The increasing U.S. reliance on natural gas imports, the
15 growing world trade in liquefied natural gas (LNG), and the tighter linkages to oil prices are
16 making natural gas forecasting an increasingly uncertain exercise.

17 **Q: What risks do we incur by becoming more dependent on imported LNG?**

18 A: As the U.S. comes to rely more and more on LNG to meet its demand for natural gas,
19 market prices will increasingly be set in a world context. In a global market with little excess
20 capacity, a supply disruption anywhere affects prices everywhere.

21 LNG is a relatively recent addition to the U.S. natural gas supply. Up until the 1990s,
22 domestic production accounted for more than 90 percent of total supplies to the U.S., with

1 pipeline imports from Canada and Mexico comprising most of the rest. High transportation costs
2 and limited pipeline capacities led to widely varying regional patterns of both consumption and
3 prices.

4 More recently, net pipeline imports of natural gas (mostly from Canada and Mexico)
5 have been declining, and the outlook is for continuing declines. Instead, it is projected that
6 overseas LNG will grow rapidly and offset these projected declines in both domestic production
7 and pipeline imports. These dramatic trends in past and projected U.S. imports of natural gas are
8 shown in OTP/MDU Exhibit 344.

9 In 2005, net LNG imports to the U.S. amounted to 0.57 trillion cubic feet, about 2.6
10 percent of the total U.S. supply.² But EIA's latest projections point to a fivefold growth in LNG
11 imports in 2030 (to 2.84 trillion cubic feet) while domestic production remains basically flat and
12 pipeline imports decrease, such that by 2030, LNG imports account for 12.5 percent of total U.S.
13 supply.

14 As dramatic as this growth in LNG is, it was not anticipated just a few years ago. In
15 OTP/MDU Exhibit 345, I have charted gas supply forecasts as developed in EIA's *Annual*
16 *Energy Outlooks* published between 1998 and 2008. The top half of OTP/MDU Exhibit 345
17 shows how the forecasts for 2010 have changed over the years, while the bottom half does the
18 same thing for EIA's 2020 forecasts. Several trends can be observed in OTP/MDU Exhibit 345.
19 First, future expectations of total gas supply and demand have generally declined in recent years,
20 especially in the past few years as price expectations have been rising. Second, expectations of

² Source: Energy Information Administration, *Annual Energy Outlook 2008*, Release date March 2008 (Revised to include the impact of H.R.6, Energy Independence and Security Act of 2007 enacted in December 2007), Reference Case Forecast, Table A13, "Natural Gas Supply and Disposition", http://www.eia.doe.gov/oiaf/aeo/pdf/aeotab_13.pdf.

1 gas supplies from the U.S. and pipeline imports from Canada and Mexico have been falling, even
 2 though prices are higher. This leads to a rapidly growing expectation of future LNG exports. Just
 3 a few years ago LNG imports were not forecasted to rise much above then-current levels.

4 **Q: How is global competition for LNG showing up in market prices?**

5 A: As LNG grows as a world-traded commodity, its price will become more determined by
 6 worldwide supply and demand factors, particularly the price of oil.

7 A page 1 story in the April 18, 2008 edition of *The Wall Street Journal* describes at
 8 length some of these interactions and concerns. In “Surge in Natural Gas Stoked by New Global
 9 Trade,”³ the reporters’ lead sentence states that “Americans feeling the pain of record gasoline
 10 prices now face the likelihood of another fuel shock, from natural gas.” The story continues with
 11 the troubling observations that prices in the U.S. have risen 93% since late August as power-
 12 hungry nations such as South Korea and Japan compete in a global natural-gas market that
 13 scarcely existed a half-decade ago, and that the global appetite for natural gas has profound
 14 implications for a U.S. economy already tipping toward recession and struggling against inflation
 15 pressures. A copy of the WSJ article is attached as OTP/MDU Exhibit 350.

16 **VI. NATURAL GAS PRICING VOLATILITY FROM CO₂ REQUIREMENTS**

17 **Q: How could requirements to reduce CO₂ emissions affect natural gas demand and**
 18 **prices?**

19 A: CO₂ requirements and/or pricing would affect the costs of using both coal and natural
 20 gas. Per million Btu, natural gas produces a little more than half the CO₂ emissions that a
 21 million Btu of coal does. Pricing these CO₂ emissions would also add to the cost of consuming

³ “Surge in Natural Gas Stoked by New Global Trade,” by Ann Davis and Russell Gold, *The Wall Street Journal*, April 18, 2008, page 1, <http://online.wsj.com/article/SB120847521878424735.html>.

1 natural gas, though by a lesser amount than for coal. Gas costs could also be affected by the
2 potential rise in market price and volatility for the fuel

3 **Q: How could requirements to reduce CO₂ emissions affect the demand for natural**
4 **gas?**

5 A: For many electric power companies, shifting to natural gas may be the only suitable CO₂
6 reduction strategy that can be implemented on a large scale. While nuclear energy is edging
7 closer to again becoming a viable option for new capacity, it cannot yet be considered as a
8 dependable near-term strategy because of licensing, timing, and cost factors. The other primary
9 source of baseload power, large hydroelectric plants, offers no reasonable opportunities for large-
10 scale additions. While renewable resources such as wind power might be able to substitute for
11 some of the fossil-fueled generation, they are intermittent and not dispatchable. To some degree,
12 energy conservation can slow the growth in electric power demand, but such energy conservation
13 is unlikely to fully offset the need for new baseload power generation.

14 **Q: What is the net effect of these changes in demand on natural gas prices?**

15 A: When there are more near-term shifts to natural gas than there are defections from natural
16 gas to other emission-reducing activities, the aggregate near-term consumption of natural gas is
17 more likely to rise relative to a scenario not requiring CO₂ reductions. It follows that near-term
18 prices for natural gas could also rise, both in absolute terms and relative to coal prices. The
19 amount that natural gas prices could rise in the near-term is dependent upon a number of factors,
20 in particular the timing and magnitude in which CO₂ emissions reduction requirements are
21 phased in, and the price of natural gas vis-à-vis coal.

22 **Q: How could CO₂ prices affect natural gas price volatility?**

1 A: Natural gas (and petroleum) prices are already much more volatile than coal prices, and
2 this price volatility creates a highly significant risk factor for an electricity generation resource
3 that relies on natural gas. With the introduction of GHG reduction requirements and CO₂ prices,
4 I would expect natural gas price volatility to increase significantly more. Even prior to CO₂
5 pricing, we have seen that relatively modest changes in the supply and/or the demand for natural
6 gas can trigger large movements in market prices. Under a future with mandatory GHG
7 reductions and CO₂ prices, energy consumers will face a new and different set of costs, and will
8 need to reassess their fuels and process strategies.

9 The extent of shifts toward or away from gas will depend upon the relative fuel prices,
10 technology costs and availability, extent of required GHG reductions, and CO₂ price levels.
11 Many of these factors will in turn depend upon all the others. With so many changes in the
12 marketplace, and with so much uncertainty as to how others will respond, we can expect to see a
13 very uncertain and volatile market for natural gas for several years as transitions are made to the
14 new GHG requirements.

15 **VII. ENERGY SUPPLY AND SECURITY RISKS OF NATURAL GAS**
16 **RELIANCE**

17 **Q: Does our increasing dependence on foreign supplies of natural gas present energy**
18 **supply and security risks?**

19 A: Yes. Our increasing reliance on natural gas supplies from overseas sources introduces
20 geopolitical risks that are not seen with coal, an almost entirely domestic fuel source.

21 It is well known that most of the world's oil reserves are found in the Middle East. As
22 seen in OTP/MDU Exhibit 346, 729 billion of the world's 1,277 billion barrels, or 57 percent,

1 are located in Middle East countries.⁴ North America is shown having 215 billion barrels, but
2 over 80 percent of this is noted as being oil sands in western Canada, where extraction poses
3 high costs.

4 A map of proven world gas reserves, shown in the bottom half of OTP/MDU Exhibit
5 346, shows a similarly worrisome situation for natural gas. Out of 6,044 trillion cubic feet of
6 proven gas reserves, over 80 percent are located in the Middle East, Eastern Europe and former
7 USSR countries, and Africa. In fact, a look at natural gas reserves by country shows that at the
8 beginning of this year, the U.S. ranked sixth in world gas reserves, with 3.1 percent of proven
9 reserves.⁵ The nine other top-ten countries in gas reserves are Russia, Iran, Qatar, Saudi Arabia,
10 Abu Dhabi, Nigeria, Algeria, Venezuela, and Iraq. These other nine countries, several of whom
11 at best are reluctant business partners with the U.S., hold gas reserves that collectively account
12 over three-fourths of the world's total.

13 With the bulk of world gas reserves concentrated in a few key countries, many of whom
14 are not especially friendly to U.S. interests, this growing dependence poses both economic and
15 national security risks. Added to that the fact that China, India, Japan, and Western Europe are
16 *not* among the large holders of oil and gas reserves, and we can easily appreciate how global
17 competition for oil and natural gas will continue to underlie international trade and security
18 concerns.

⁴ Source: Adapted from Kevin R. Petak, Energy and Environmental Analysis, Inc., *Oil and Gas Prices: Will They Stay Linked?*, presented at 2006 EIA Energy Outlook and Modeling Conference, Washington DC, March 27, 2006, <http://www.eia.doe.gov/oiaf/aeo/conf/pdf/petak.pdf>. Original data source is *Oil and Gas Journal*.

⁵ Oil and Gas Journal, "Worldwide Natural Gas Reserves by Country (annual) – data thru 2006", <http://ogjresearch.stores.yahoo.net/wornatgasres.html>. Estimated at January 1, 2006, U.S. reserves totaled 192,513 billion cubic feet, 3.15 percent of the world's total of 6,112,144 billion cubic feet. The other nine top-ten countries held 4,610,020 billion cubic feet, 75.42 percent of the world's total.

1 **VIII. NATURAL GAS RISKS IN THE MIDWEST ISO**

2 **Q: What did Mr. Schlissel say regarding over-reliance on natural gas?**

3 A: Mr. Schlissel stated that he agreed “that over-reliance on natural gas can be a concern.”
4 (Schlissel, p. 8) However, he stated that “in this specific instance and in this specific area of the
5 nation, it does not appear that the MRO would be overly reliant on natural gas if the Commission
6 rejected OTP and MDU request to build the Big Stone II Project.”

7 Mr. Schlissel’s conclusion seems to be based on figures drawn from the NERC 2007
8 *Long-Term Assessment Reliability Assessment 2007-2016*. Those figures showed little projected
9 change in the shares of coal and gas-fired capacity over the next few years, and that the
10 replacement of Big Stone II by natural gas would not significantly change those figures. He
11 concludes that “there is no real danger of over-reliance on natural gas in the upper Midwest. There
12 could be a concern in other regions of the nation but not in the upper Midwest.”

13 **Q: Do you agree with Mr. Schlissel that the Big Stone II partners have no real danger**
14 **of over-reliance on natural gas?**

15 A: No. In looking only at capacity shares by fuel, Mr. Schlissel ignores the Applicants’
16 participation in coordinated regional operations, and how that already exposes them to larger gas
17 risks. Further, this exposure is expected to grow dramatically.

18 The Midwest Independent Transmission System Operator, Inc. (Midwest ISO, or MISO)
19 serves a large region that covers all or most of North Dakota, South Dakota, Nebraska,
20 Minnesota, Iowa, Wisconsin, Illinois, Indiana, Michigan and parts of Montana, Missouri,
21 Kentucky, and Ohio. The Applicants are members of MISO.

1 Established in 2002 as a regional reliability organization, MISO provides a number of
2 services that provide economic and reliability benefits to its members. Since April 2005, MISO
3 has administered a two-settlement (day ahead and real-time) energy market known as the Day-2
4 market. As described by FERC, in real-time market operations MISO centrally dispatches
5 wholesale electricity and transmission service throughout much of the Midwest.

6 **Q: As members of MISO, are the Applicants exposed to natural gas availability and**
7 **pricing?**

8 Yes. The MISO market produces Locational Marginal Prices (LMP) for five-minute
9 intervals in the MISO market footprint. Because of line losses and potential congestion, prices
10 are set for five hubs, with the one in Minnesota being the closest one to North Dakota.
11 Locational Marginal Pricing provides price transparency for users of the wholesale bulk electric
12 system, and indicates the cost of conducting business based on current system conditions. If
13 natural gas use is growing, it will more often be the marginal resource that sets the LMP price.
14 And with the higher volatility seen in natural gas prices, both historically and projected, it is
15 reasonable to expect that the LMP price would be similarly more volatile. Natural gas-fired
16 generation is becoming a significant driver of the pricing in the MISO energy market.

17 **Q: How will the region's increasing dependence on natural gas for power generation**
18 **affect customers of Big Stone II?**

19 A: As natural gas use for power generation increases, it will more often be the marginal
20 resource that sets MISO's LMP price. Gas prices and price volatility will increasingly affect Big
21 Stone II customers via the prices in MISO's wholesale power transactions.

1 If Big Stone II were to be replaced by a natural gas-fired alternative, this exposure to gas
2 prices and price volatility would be further exacerbated. For Big Stone II customers, the
3 exposure would now be in the generating mix as well as purchases in the MISO markets.

4 Further, when there are problems with the availability, deliverability, and/or price of
5 natural gas, it will affect a broader portion of the area, and the diversity that coal would have
6 provided would be lost. Accordingly, looking only at the generating assets of a single utility
7 provides a misleading picture. It is appropriate to consider the mix of assets in the broader
8 reliability system in which it operates.

9 **IX. IMPACTS ON ELECTRICITY CONSUMERS AND HOUSEHOLDS**

10 **Q: What is the potential magnitude of price changes in the context of this project?**

11 A: Since a 500 MW unit consumes such large quantities of fuel, even small changes in fuel
12 prices amount to very large changes in annual costs. For illustration, assume that if instead of
13 coal, a natural gas combined cycle (NGCC) plant was proposed. If the NGCC plant was 500
14 MW, had a 7200 Btu/kWh heat rate, and operated at an 88% capacity factor, then each year it
15 would generate about 3.85 million MWh and consume about 28 million MMBtu of gas. For this
16 single unit, then, a change in gas prices of only \$0.01 per MMBtu over the course of a year
17 would change total costs by about \$280,000. If future natural gas prices are uncertain by \$1.00
18 per MMBtu (or more), then total annual costs for a gas-fueled alternative to Big Stone II may
19 vary by about \$28 million dollars per year. And, as noted earlier, just since the beginning of
20 2006, there have been at least four months in which the U.S. average price of natural gas
21 delivered to the electric power sector has risen or fallen by over \$1.00 per mcf from the previous
22 month.

1 **Q: Are Big Stone II customers at greater than average risk for fuel price volatility?**

2 A: Yes. In addition to electricity, we use substantial amounts of natural gas and petroleum
3 in the residential sector. Nationally, this direct consumption of natural gas and petroleum in the
4 residential sector is substantially greater than the electrical energy consumed. It follows that if
5 this non-electric residential energy consumption is weighted heavily toward price-volatile energy
6 sources, then the reliance upon those same energy sources for Big Stone II could exacerbate the
7 overall volatility risks for the Applicants' customers.

8 Households in North Dakota and other West North Central states have higher than
9 average consumption of natural gas and petroleum. This greater consumption is related to higher
10 winter heating needs that largely utilize natural gas and petroleum fuels. Using data on heating
11 and cooling degree-days, as reported by the Energy Information Administration, we can see that
12 the West North Central region (comprised of Iowa, Kansas, Minnesota, Missouri, Nebraska,
13 North Dakota, and South Dakota) is substantially colder than average in the winter, and
14 somewhat cooler on average in the summer.⁶ For heating degree-days over the 1971-2000
15 period, the West North Central region averaged more heating degree-days than any other Census
16 region, 49.2 percent higher than the U.S. average. Conversely, the somewhat cooler-than-
17 average summers led to the West North Central having 23.6 percent fewer cooling degree-days
18 than the U.S. average.

19 Whereas summer cooling needs are typically met using electricity-driven air conditioners
20 and fans, winter heating needs are more often met by direct household use of natural gas and

⁶ Energy Information Administration, *Annual Energy Review 2006*, Tables 1.9 and 1.10, at <http://www.eia.doe.gov/emeu/aer/>.

1 petroleum fuels. It would tend to follow that the colder regions of the country would have greater
2 household consumption of natural gas and petroleum fuels.

3 The Energy Information Administration, in its periodic *Residential Energy Consumption*
4 *Survey (RECS)*, develops state-wide estimates of energy consumption by type of fuel. EIA's
5 most recent published estimates are for calendar year 2001. By dividing these estimates by the
6 number of housing units in these states for 2001 (using Census Bureau data), we can attain per-
7 household estimates of energy consumption, by state and by type of fuel.

8 OTP/MDU Exhibit 347 summarizes these per-household calculations of residential
9 energy use. As can be seen, North Dakota had both a higher-than-average consumption of non-
10 electrical residential energy consumption and a greater proportion of that as natural gas and
11 petroleum fuels. For non-electric energy consumption, the average North Dakota household in
12 2001 consumed 76.3 MMBtu, thirty percent more than the national average of about 58.5
13 MMBtu per household. Nearly all of this was natural gas and petroleum fuels.

14 The heavy reliance on natural gas and petroleum fuels in the residential sector brings with
15 it another risk of natural gas as a power plant fuel for North Dakotans. If natural gas is used as an
16 energy source instead of coal at Big Stone II, there is an overall loss of fuel supply diversity. If
17 natural gas supplies are constrained in supply and/or subjected to price spikes, residences can be
18 hit twice – once in their direct consumption of fuel, and again in their use of natural gas-fueled
19 electricity.

20 **Q: Are Big Stone II customers exposed to relatively greater risk to electricity price**
21 **increases?**

1 A: Yes. Big Stone II customers are at relatively greater risk in two ways. First, they consume
2 greater than average amounts of electricity. Second, household income is generally lower than
3 average.

4 In OTP/MDU Exhibit 347, it was seen that North Dakota has a higher-than average per-
5 household consumption of both electricity and non-electric energy. Electricity consumption, at
6 40.7 MMBtu per household in 2001, was 17 percent above the national average. It follows that
7 an increase in the electricity rate will result in comparably higher monthly bills.

8 At the same time, North Dakota tends to have household incomes that are lower than the
9 national average. In OTP/MDU Exhibit 348, I have compiled data from the U.S. Census Bureau
10 on median household incomes for the U.S. and the North Dakota counties to be served by Big
11 Stone II. The Census Bureau data consists of model-based estimates of poverty and income for
12 states and counties, and is developed from its Small Area Income and Poverty Estimates
13 (SAIPE) program. The latest estimates are for calendar year 2005, and can be referenced at
14 <http://www.census.gov/hhes/www/saipe/county.html>. The staff at Otter Tail Power Company
15 helped me to match the customers' communities to their respective counties. In all, Otter Tail
16 will serve portions of 12 of North Dakota's 53 counties from Big Stone II, and for each I
17 compared the median household income in 2005 to the U.S. average.

18 As seen in OTP/MDU Exhibit 348, U.S. median household income was \$46,242 in 2005.
19 North Dakota ranked 38th among states (including the District of Columbia); at \$40,818 per
20 household, North Dakotans' median household income was only 88 percent of the U.S average.
21 And of the 12 North Dakota counties to be served by Otter Tail from Big Stone II, for instance,
22 all but one were below the U.S. average, and nine were below the North Dakota average.

1 This combination of higher household energy use and lower household income is a risky
2 situation for consumers. Higher electricity rates would be applied to more kWh, and with less
3 disposable income to pay for it. Accordingly, the higher energy costs reduce the disposable
4 income available for other purposes, and this impact would be disproportionately felt on higher
5 consuming, lower income households.

6 **X. CONCLUSION**

7 **Q: Does this conclude your testimony?**

8 **A: Yes.**

APPENDIX A

EXHIBITS

PREFILED REBUTTAL TESTIMONY

OF

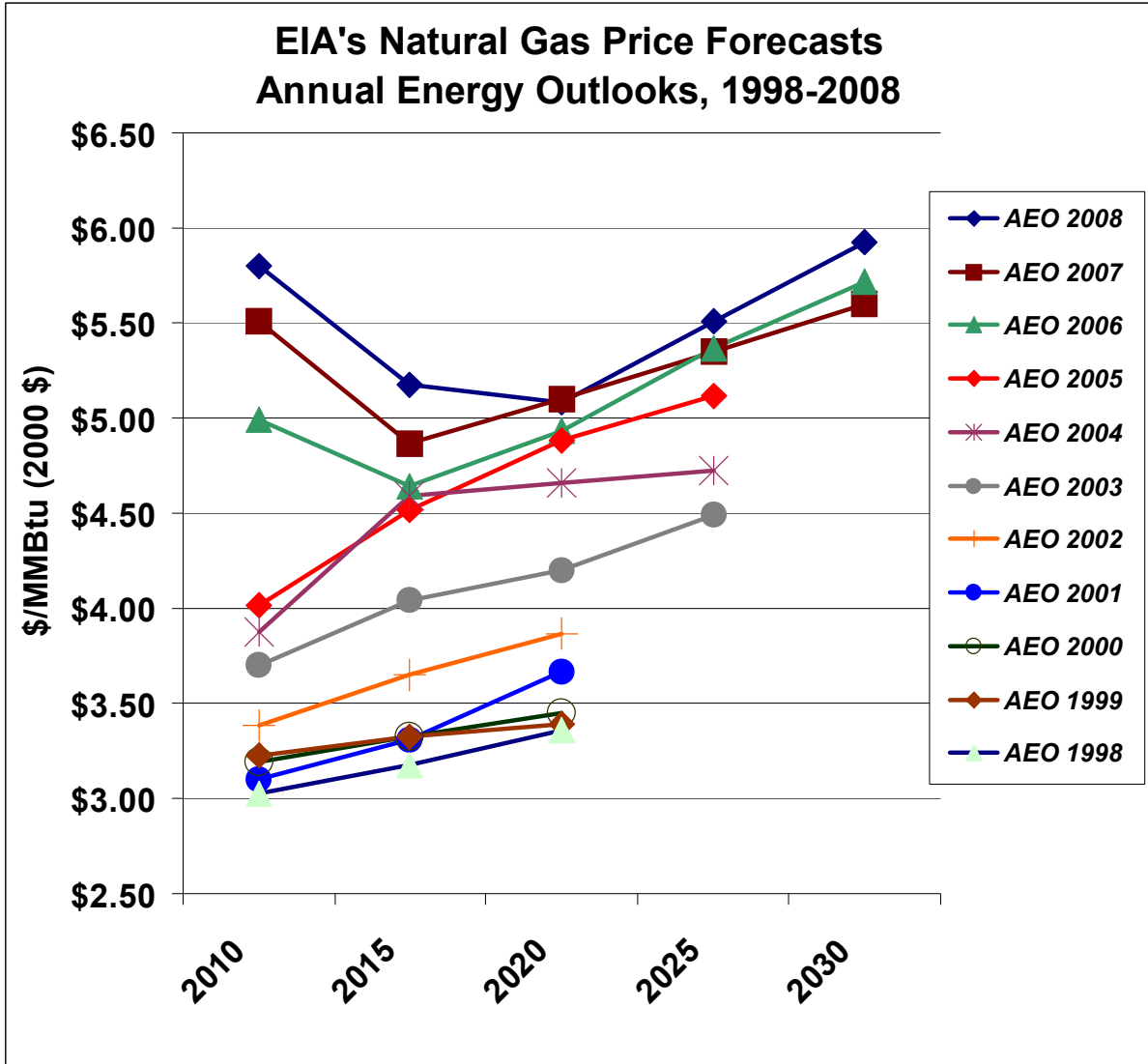
DANIEL KLEIN

PRESIDENT

TWENTY-FIRST STRATEGIES, LLC

APRIL 23, 2008

OTP/MDU EXHIBIT 342
HISTORY OF NATURAL GAS PRICE FORECASTS MADE BY THE ENERGY
INFORMATION ADMINISTRATION (\$/MMBtu, in year 2000 dollars)



Source: Compiled from U.S. Dept. of Energy, Energy Information Administration, *Annual Energy Outlook*, yearly publications, 1998 through 2008. Reference Case Tables' prices converted from various year dollars to 2000 dollars by dividing by a GDP Implicit Price Deflator, based on U.S. GDP data, as reported in U.S. Department of Commerce, Bureau of Economic Analysis, *National Economic Accounts: Gross Domestic Product, Current-dollar and "real" GDP*, spreadsheet at <http://www.bea.gov/national/xls/gdplev.xls>, last updated 27-Sep-2007.

OTP/MDU EXHIBIT 343
CHANGES IN COAL AND NATURAL GAS PRICE FORECASTS TO ELECTRIC GENERATORS, AS COMPILED FROM ANNUAL ENERGY OUTLOOK, 1998-2006

A. Forecast prices in real \$ per MMBtu, using \$ base year as given in that year's AEO

<u>Source</u>	<u>Table/Page</u>	<u>Year \$</u>	<u>Coal</u>			<u>Natural Gas</u>		
			<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
AEO 1998	Table A3, Page 104	1996	\$ 1.09	\$ 1.03	\$ 0.97	\$ 2.84	\$ 2.98	\$ 3.15
AEO 1999	Table A3, Page 116	1997	\$ 1.06	\$ 0.99	\$ 0.93	\$ 3.08	\$ 3.17	\$ 3.24
AEO 2000	Table A3, Page 121	1998	\$ 1.07	\$ 1.03	\$ 0.98	\$ 3.08	\$ 3.21	\$ 3.33
AEO 2001	Table A3, Page 131	1999	\$ 1.05	\$ 1.01	\$ 0.98	\$ 3.03	\$ 3.24	\$ 3.59
AEO 2002	Table A3, Page 129	2000	\$ 1.05	\$ 1.01	\$ 0.97	\$ 3.38	\$ 3.65	\$ 3.87
AEO 2003	Table A3, Page 123	2001	\$ 1.17	\$ 1.15	\$ 1.12	\$ 3.79	\$ 4.14	\$ 4.30
AEO 2004	Table A3, Page 137	2002	\$ 1.22	\$ 1.20	\$ 1.17	\$ 4.04	\$ 4.78	\$ 4.85
AEO 2005	Table A3, Page 143	2003	\$ 1.25	\$ 1.23	\$ 1.25	\$ 4.27	\$ 4.81	\$ 5.20
AEO 2006	Table A3, Page 137	2004	\$ 1.48	\$ 1.40	\$ 1.39	\$ 5.46	\$ 5.08	\$ 5.40
AEO 2007	Table A3, Page 140	2005	\$ 1.71	\$ 1.60	\$ 1.58	\$ 6.22	\$ 5.50	\$ 5.76

B. Forecast prices in real \$ per MMBtu, using year 2000 dollars

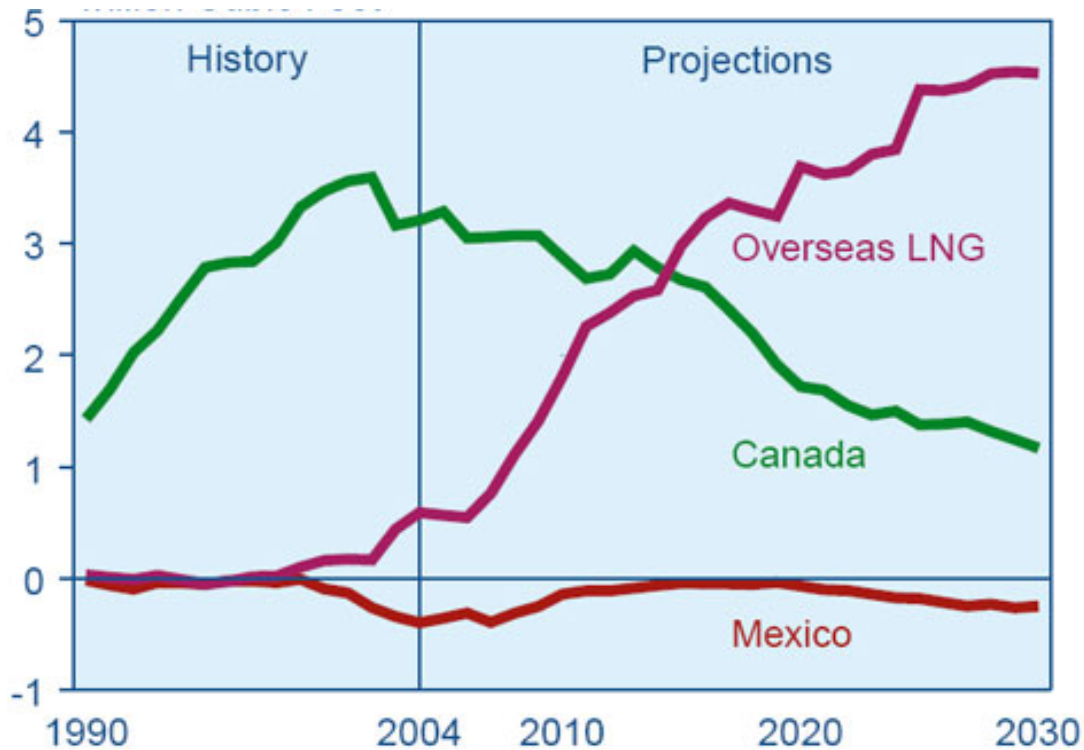
<u>Source</u>	<u>Table/Page</u>	<u>GDP Price Deflator</u>	<u>Coal</u>			<u>Natural Gas</u>		
			<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
AEO 1998	Table A3, Page 104	0.9385	\$ 1.16	\$ 1.10	\$ 1.03	\$ 3.03	\$ 3.18	\$ 3.36
AEO 1999	Table A3, Page 116	0.9541	\$ 1.11	\$ 1.04	\$ 0.97	\$ 3.23	\$ 3.32	\$ 3.40
AEO 2000	Table A3, Page 121	0.9647	\$ 1.11	\$ 1.07	\$ 1.02	\$ 3.19	\$ 3.33	\$ 3.45
AEO 2001	Table A3, Page 131	0.9787	\$ 1.07	\$ 1.03	\$ 1.00	\$ 3.10	\$ 3.31	\$ 3.67
AEO 2002	Table A3, Page 129	1.0000	\$ 1.05	\$ 1.01	\$ 0.97	\$ 3.38	\$ 3.65	\$ 3.87
AEO 2003	Table A3, Page 123	1.0240	\$ 1.14	\$ 1.12	\$ 1.09	\$ 3.70	\$ 4.04	\$ 4.20
AEO 2004	Table A3, Page 137	1.0419	\$ 1.17	\$ 1.15	\$ 1.12	\$ 3.88	\$ 4.59	\$ 4.66
AEO 2005	Table A3, Page 143	1.0641	\$ 1.17	\$ 1.16	\$ 1.17	\$ 4.01	\$ 4.52	\$ 4.89
AEO 2006	Table A3, Page 137	1.0946	\$ 1.35	\$ 1.28	\$ 1.27	\$ 4.99	\$ 4.64	\$ 4.93
AEO 2007	Table A3, Page 140	1.1300	\$ 1.51	\$ 1.42	\$ 1.40	\$ 5.50	\$ 4.87	\$ 5.10

C. Change in forecast prices from previous year's AEO

<u>Source</u>	<u>Measure</u>	<u>Year \$</u>	<u>Coal</u>			<u>Natural Gas</u>		
			<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
AEO 1998	--	2000	--	--	--	--	--	--
AEO 1999	Change from AEO 1998	2000	\$ (0.05)	\$ (0.06)	\$ (0.06)	\$ 0.20	\$ 0.15	\$ 0.04
AEO 2000	Change from AEO 1999	2000	\$ (0.00)	\$ 0.03	\$ 0.04	\$ (0.04)	\$ 0.01	\$ 0.06
AEO 2001	Change from AEO 2000	2000	\$ (0.04)	\$ (0.04)	\$ (0.01)	\$ (0.10)	\$ (0.02)	\$ 0.22
AEO 2002	Change from AEO 2001	2000	\$ (0.02)	\$ (0.02)	\$ (0.03)	\$ 0.28	\$ 0.34	\$ 0.20
AEO 2003	Change from AEO 2002	2000	\$ 0.09	\$ 0.11	\$ 0.12	\$ 0.32	\$ 0.39	\$ 0.33
AEO 2004	Change from AEO 2003	2000	\$ 0.03	\$ 0.03	\$ 0.03	\$ 0.18	\$ 0.54	\$ 0.46
AEO 2005	Change from AEO 2004	2000	\$ 0.00	\$ 0.00	\$ 0.05	\$ 0.14	\$ (0.07)	\$ 0.23
AEO 2006	Change from AEO 2005	2000	\$ 0.18	\$ 0.12	\$ 0.10	\$ 0.98	\$ 0.12	\$ 0.05
AEO 2007	Change from AEO 2006	2000	\$ 0.16	\$ 0.14	\$ 0.13	\$ 0.52	\$ 0.23	\$ 0.16

Source: U.S. Dept. of Energy, Energy Information Administration, *Annual Energy Outlook*, yearly publications, 1998 through 2007. Reference Case Tables' prices converted from various year dollars to 2000 dollars by dividing by a GDP Implicit Price Deflator, based on U.S. GDP data, as reported in U.S. Department of Commerce, Bureau of Economic Analysis, National Economic Accounts: *Gross Domestic Product, Current-dollar and "real" GDP*, spreadsheet at <http://www.bea.gov/national/xls/gdplev.xls>, last updated 27-Sep-2007.

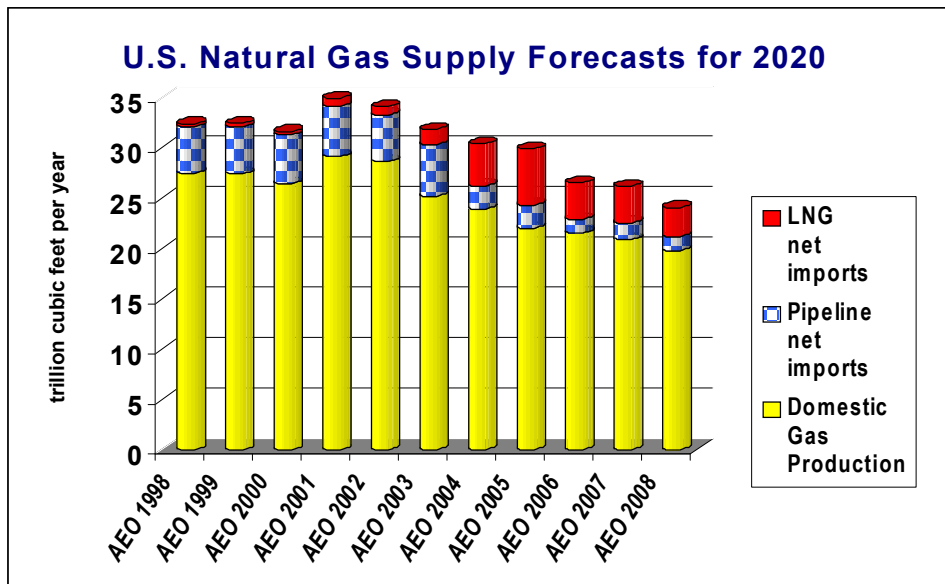
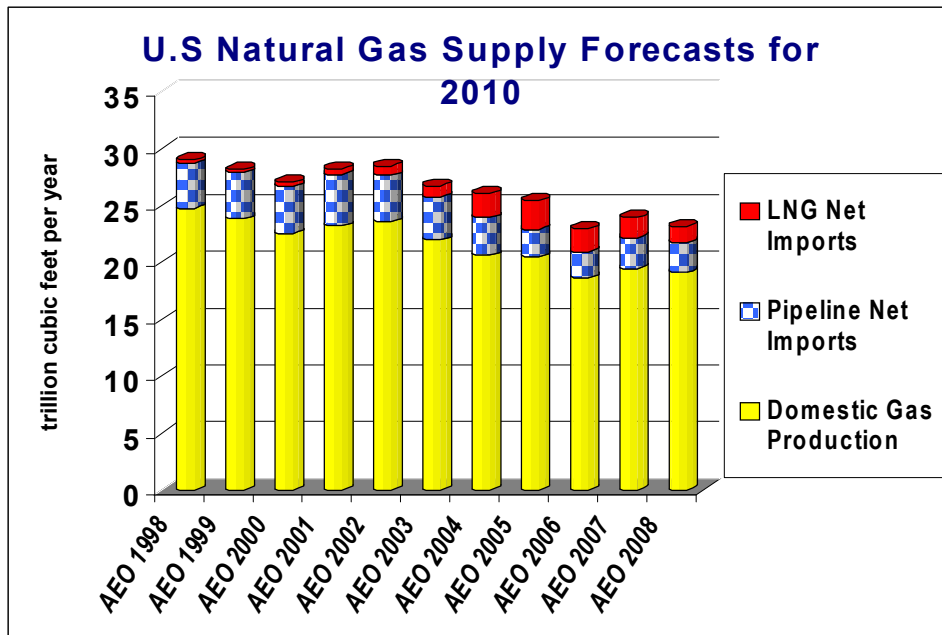
OTP/MDU EXHIBIT 344
U.S. NET IMPORTS OF NATURAL GAS BY SOURCE, 1990-2030
(trillion cubic feet)



Source: U.S. Department of Energy, Energy Information Administration, *International Energy Outlook 2007*, Report #DOE/EIA-0484(2007), May 2007, Figure 46.
http://www.eia.doe.gov/oiaf/ieo/figure_46.html. Figure developed using historic data in *Annual Energy Review 2005* and forecasts in *Annual Energy Outlook 2007*.

OTP/MDU EXHIBIT 345

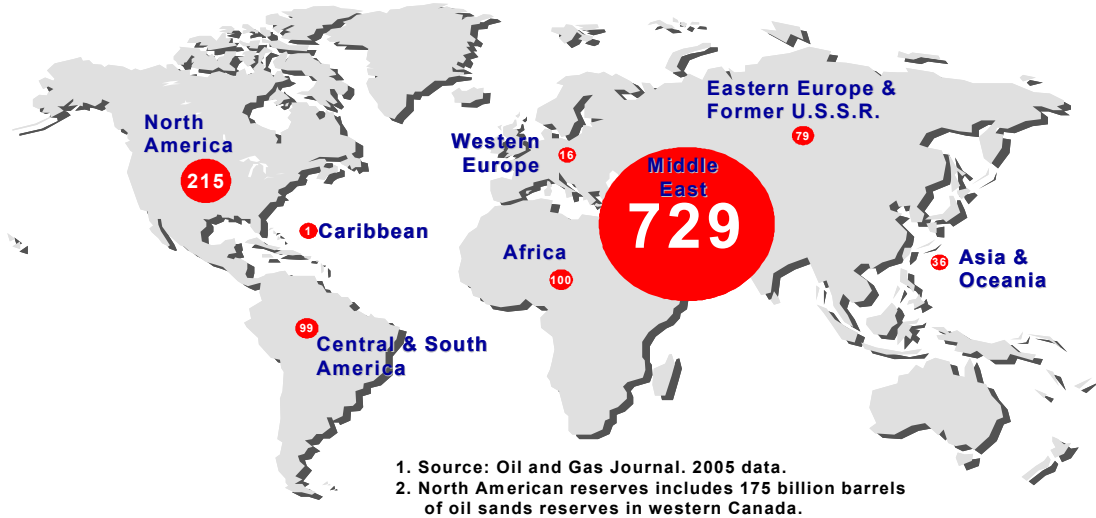
HISTORICAL COMPARISON OF NATURAL GAS SUPPLY FORECASTS



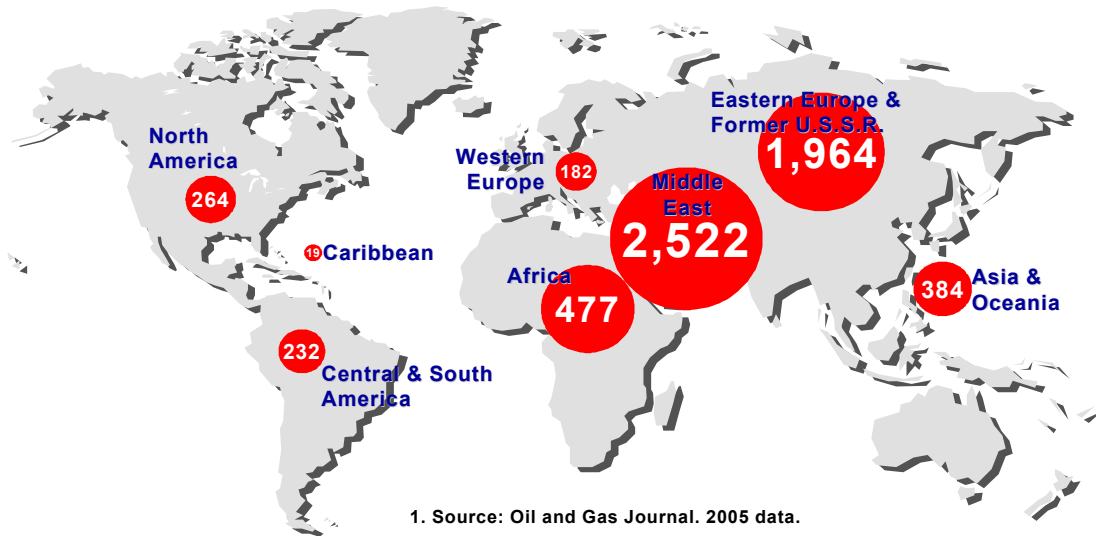
Source: Developed from Energy Information Administration, *Annual Energy Outlook*, various editions 1998 through 2008, Reference Case Forecast, Table A13, "Natural Gas Supply and Disposition", archive listings available at <http://www.eia.doe.gov/oiaf/archive.html#aao>.

**OTP/MDU EXHIBIT 346
LOCATION OF WORLD OIL AND NATURAL GAS RESERVES**

Proven World Oil Reserves: 1,277 Billion Barrels



Proven World Gas Reserves: 6,044 Trillion Cubic Feet



Source: Adapted from Kevin R. Petak, Energy and Environmental Analysis, Inc., *Oil and Gas Prices: Will They Stay Linked?*, presented at 2006 EIA Energy Outlook and Modeling Conference, Washington DC, March 27, 2006, <http://www.eia.doe.gov/oiaf/aeo/conf/pdf/petak.pdf>. Data source for chart is *Oil and Gas Journal*.

OTP/MDU EXHIBIT 347
AVERAGE PER-HOUSEHOLD ENERGY CONSUMPTION, 2001
(MMBtu per household)

State	Census Region	Net Energy	Electricity	Non-electric Energy			
				Total Non-electric	Natural Gas	Petroleum	Other
Alabama	ESC	83.2	47.5	35.7	25.4	7.4	2.9
Alaska	PAC	141.4	24.7	116.7	64.6	43.7	8.4
Arizona	MTN	63.0	39.5	23.5	16.5	1.9	5.2
Arkansas	WSC	86.0	43.2	42.8	31.6	8.6	2.4
California	PAC	68.9	21.3	47.5	42.1	1.4	4.1
Colorado	MTN	102.2	26.3	75.8	66.1	5.3	4.4
Connecticut	NE	125.3	29.3	96.0	29.8	61.1	5.0
Delaware	SA	95.7	36.4	59.3	27.2	28.4	3.7
District of Columbia	SA	77.5	20.7	56.7	48.4	4.4	4.0
Florida	SA	55.3	46.2	9.1	2.2	1.9	4.9
Georgia	SA	88.5	44.5	44.0	36.5	3.9	3.6
Hawaii	PAC	28.1	20.6	7.5	1.3	3.4	2.8
Idaho	MTN	95.5	43.6	51.9	36.0	12.0	4.1
Illinois	ENC	122.8	28.9	94.0	88.2	3.5	2.3
Indiana	ENC	107.7	38.9	68.8	58.5	7.7	2.6
Iowa	WNC	107.3	34.0	73.3	57.2	12.0	4.1
Kansas	WNC	107.0	35.9	71.1	61.5	6.2	3.4
Kentucky	ESC	88.0	45.4	42.6	33.2	6.1	3.4
Louisiana	WSC	80.1	47.1	33.0	26.9	4.1	2.0
Maine	NE	113.1	24.6	88.5	1.7	82.0	4.9
Maryland	SA	94.9	37.6	57.2	36.7	16.8	3.8
Massachusetts	NE	122.4	23.2	99.1	42.3	52.0	4.9
Michigan	ENC	126.0	25.7	100.4	82.5	15.6	2.3
Minnesota	WNC	110.1	31.4	78.6	60.0	15.0	3.6
Mississippi	ESC	88.3	48.5	39.8	24.1	12.8	2.9
Missouri	WNC	106.6	41.5	65.1	47.2	14.2	3.6
Montana	MTN	96.0	32.0	64.0	49.6	10.6	4.1
Nebraska	WNC	117.1	40.2	76.9	64.6	8.7	3.5
Nevada	MTN	84.6	37.9	46.8	38.6	3.7	4.5
New Hampshire	NE	103.8	23.3	80.6	13.0	62.6	4.7
New Jersey	MA	112.8	25.9	86.8	65.1	19.3	2.4
New Mexico	MTN	86.5	21.5	65.0	44.8	15.7	4.4
New York	MA	110.8	19.5	91.4	50.3	31.5	9.5
North Carolina	SA	78.6	43.4	35.2	16.3	15.3	3.7
North Dakota	WNC	117.0	40.7	76.3	37.3	34.6	4.4
Ohio	ENC	109.2	33.4	75.8	66.5	7.1	2.3
Oklahoma	WSC	95.1	44.1	51.0	43.3	5.9	1.8
Oregon	PAC	79.5	40.4	39.0	26.7	6.5	5.8
Pennsylvania	MA	108.8	29.9	78.9	47.6	28.5	2.8
Rhode Island	NE	117.2	20.8	96.4	41.9	49.8	4.8
South Carolina	SA	72.6	47.2	25.4	15.8	5.9	3.6
South Dakota	WNC	99.7	37.1	62.6	37.4	21.6	3.6
Tennessee	ESC	86.9	50.6	36.3	28.4	4.9	3.1
Texas	WSC	80.0	47.9	32.1	25.5	5.3	1.2
Utah	MTN	111.6	28.9	82.8	73.3	5.3	4.1
Vermont	NE	108.7	23.2	85.4	9.4	71.7	4.7
Virginia	SA	88.7	42.9	45.8	24.6	17.3	3.9
Washington	PAC	91.4	43.2	48.3	35.0	7.9	5.4
West Virginia	SA	95.2	39.3	55.9	41.9	10.1	3.6
Wisconsin	ENC	103.3	29.5	73.8	53.5	17.9	2.4
Wyoming	MTN	100.9	32.3	68.6	51.3	11.9	5.3
United States		93.3	34.8	58.5	41.6	13.1	3.8

Source: Residential energy consumption data from Energy Information Administration, "State Data: Table S4: Residential Sector Energy Consumption Estimates, 2001," http://www.eia.doe.gov/emeu/states/sep_sum/html/sum_btus_res.html. Household data from U.S. Bureau of the Census, "Annual Estimates of Housing Units for the United States and States: April 1, 2000 to July 1, 2004," Publication HU-EST2004-01, at <http://www.census.gov/popest/housing/tables/HU-EST2004-01.xls>.

OTP/MDU EXHIBIT 348
MEDIAN 2005 HOUSEHOLD INCOME FOR NORTH DAKOTA COUNTIES
TO BE SERVED BY BIG STONE II

State	County	Companies Serving	Median household income (2005\$)	% of U.S. Income
United States			\$46,242	100.00%
North Dakota (<i>ranked #38 among States & D.C.</i>)			\$40,818	88.27%
	Barnes County	MRE, OTPC	\$39,627	85.69%
	Burleigh County	MDU, OTPC	\$47,080	101.81%
	Dickey County	MDU, OTPC	\$35,211	76.15%
	Grand Forks County	MRE, OTPC	\$41,507	89.76%
	Kidder County	MDU, OTPC	\$30,393	65.73%
	Logan County	MDU, OTPC	\$31,899	68.98%
	McLean County	MRE, OTPC	\$37,652	81.42%
	Mountrail County	MDU, OTPC	\$34,541	74.70%
	Nelson County	MRE, OTPC	\$31,715	68.58%
	Pembina County	MRE, OTPC	\$37,531	81.16%
	Renville County	MDU, OTPC	\$36,748	79.47%
	Traill County	MRE, OTPC	\$42,577	92.07%

Source: Tabulated from U.S. Census Bureau, *Small Area Income & Poverty Estimates (SAIPE): Median household income, in dollars, 2005*, <http://www.census.gov/hhes/www/saipe/county.html>. Staff of Otter Tail Power Company identified the counties with communities to be served by Big Stone II.

Code to Company names: MRE=Missouri River Energy, MDU=Montana-Dakota Utilities, OTPC=Otter Tail Power Company.

APPENDIX B

RESUME OF DANIEL E. KLEIN

Twenty-First Strategies

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 6595 Terri Knoll Court
 McLean, VA 22101

phone (703) 893-8333
 fax (703) 893-8813
 dklein@21st-strategies.com

RESUME

DANIEL E. KLEIN

EDUCATION

1975	M.B.A., Graduate School of Business, Stanford University
1973	S.B., Urban Studies, Massachusetts Institute of Technology

EXPERIENCE

Daniel E. Klein, President of Twenty-First Strategies, has over 30 years of consulting experience in energy, environmental, and economic analysis. For many years a Senior Vice President and Director of ICF Resources Incorporated, he founded Twenty-First Strategies in 1995 to offer energy and environmental consulting services to energy companies, government agencies, and others.

Over the course of his consulting career, Mr. Klein has conducted hundreds of projects related to energy and environmental concerns, energy markets, electric utility fuel use, coal supply, transportation, and antitrust issues. His work in recent years has focused primarily on climate change, electric power, and related issues, both on policy issues from the government side as well as strategies for the private sector. Mr. Klein earned a Bachelor's degree from MIT and an MBA from the Stanford Graduate School of Business. Selected examples of his recent work include the following:

Environmental Policy and Analysis

- **Global Climate Change and Electric Utilities.** Mr. Klein has directed efforts with electric utilities and government agencies to develop data and methods for assessing and planning for potential climate change initiatives. These efforts include developing new analytic frameworks for estimating potential impacts on electric power systems, and evaluating risk mitigation strategies. He directed efforts to assist the Administration develop and implement portions of the Climate Change Action Plan in the 1990s, and is continuing a variety of analytic efforts related to the Global Climate Change Initiative. In the electric utility/DOE Climate Challenge program, he was responsible for recruiting new member utilities and for helping measure and report on progress made. He is presently working with electric utilities and others to identify and implement voluntary programs to reduce greenhouse gas emissions as part of their efforts under the Power PartnersSM program.
- **Environmental Externalities.** Mr. Klein has directed several efforts supporting the U.S. Department of Energy in matters related to the use of environmental externalities. For DOE's Fossil Energy office, he directed an assessment of the socioeconomic impacts associated with potential rate increases that may result from the inclusion of externalities in electric power resource planning. He

1 has provided internal critiques and analytic support to efforts to use the damage function approach
 2 for quantifying externalities. Working with private sector groups, he has developed a framework for
 3 evaluating mortality implications stemming from income effects of changes in power costs, and has
 4 used this framework in testimony.

- 5 • **Carbon Sequestration.** Mr. Klein has provided numerous support efforts to DOE’s Carbon
 6 Sequestration Program since its inception. He has co-authored over 20 papers and conference
 7 presentations communicating the potential for carbon sequestration and DOE’s activities in this
 8 area. He has additionally co-authored several book chapters and industry journal articles on the
 9 topic. He assisted DOE in its review of the recent draft IPCC Special Report on Carbon Dioxide
 10 Capture and Storage. He developed, compiled, and maintains what has become the most
 11 comprehensive database of carbon sequestration R&D activities available, and made this available
 12 via the Internet at <http://carbonsequestration.us>.
- 13 • **Clean Air Act Analyses.** In numerous studies for public and private sector clients, Mr. Klein has
 14 analyzed the impacts of acid rain mitigation proposals, New Source Performance Standards, NO_x
 15 restrictions, and several other Clean Air Act issues on the electricity, coal, transportation, and labor
 16 markets. He developed state-of-the-art models and approaches for estimating impacts on electric
 17 utilities, coal mining, and transportation industries.
- 18 • **Climate Change Mitigation Strategy in Eastern Europe.** Mr. Klein led the U.S. portion of a
 19 multinational team to create a climate change strategy for the city of Donetsk, Ukraine. Under
 20 funding provided by U.S. Agency for International Development, Twenty-First Strategies partnered
 21 with the Ecology and Environment Department of the Donetsk City Council and the U.S.-based
 22 Center for Clean Air Policy. The project developed a GHG inventory for the city of Donetsk, and
 23 identified potential GHG mitigation activities and the associated cost and effectiveness.
- 24 • **Utility Coal Combustion By-Products.** Mr. Klein has analyzed issues related to disposal practices
 25 and potential standards for electric utility ash and sludge wastes. These efforts have included
 26 estimating past and future waste disposal volumes, identifying current regulatory requirements, and
 27 evaluating the costs and other potential impacts of alternative waste management practices.
 28 Working with the American Coal Ash Association, Utility Solid Waste Action Group, and others, he
 29 has directed studies and made conference presentations concerning beneficial use of coal
 30 combustion by-products and associated reductions in greenhouse gas emissions.
- 31 • **Environmental Aspects of Coal Mining and Transportation.** Mr. Klein has led numerous studies of
 32 the impacts of strip mining regulations, fugitive dust limits for surface coal mining, federal coal
 33 leasing policies, environmental impacts of rail deregulation, and related issues.
- 34 • **Oil Spill Environmental Impacts.** On behalf of several Alaskan Native Corporations, Mr. Klein
 35 directed litigation support efforts related to the Exxon VALDEZ oil spill. These efforts have
 36 included field and technical studies, economic impacts, and impacts on land values.

37 **Economic and Market Analysis and Forecasting**

- 38 • **Energy Market Forecasting.** For 20 years, Mr. Klein directed major portions of ICF Resources'
 39 extensive efforts in forecasting short- and long-term conditions in the fuel and power markets. He
 40 developed forecasting methodologies and related data bases, developed and enhanced ICF's Coal
 41 and Electric Utilities Model, and designed its successor models. These models and methodologies
 42 were used in dozens of market and strategic studies for private clients and policy analyses for the
 43 public sector.
- 44 • **Antitrust Market Analysis.** In major antitrust cases, Mr. Klein has served as an expert witness in the
 45 identification of relevant coal and transportation markets. In work with the Department of Justice

1 and major coal companies, he tested and implemented new market delineation techniques based
 2 upon demand cross-elasticities; this work currently serves as the basis for Department of Justice
 3 policy. Mr. Klein has also testified as a witness before the ICC on issues regarding railroad
 4 transportation markets, and in private antitrust cases.

- 5 • ***Energy and Mineral Appraisals.*** Rapid swings in energy and minerals markets over the past two
 6 decades have led to sharp changes in the value of reserves and producing operations. Appraisals
 7 have often been needed to set property values at different points in time for tax basis determination,
 8 prudence of procurement decisions, losses resulting from federal takings, property tax assessments,
 9 and other purposes. Mr. Klein has led numerous projects relating to reconstructing appraisals
 10 appropriate to past market conditions and knowledge. These efforts have included oil, gas, coal,
 11 geothermal, and various metals and mineral properties.

12 **Energy and Transportation Issues**

- 13 • ***Energy Security.*** As oil and gas prices reach historically high levels, our dependence on foreign
 14 sources creates massive economic outflows to countries that are often unfriendly to our interests.
 15 The continuing high level of oil imports, together with our growing reliance on imported liquefied
 16 natural gas, create security concerns as well as economic ones. Together with growing pressures to
 17 act on climate change, we face a “perfect storm” of intertwined energy, security, and climate
 18 problems – a once-in-a-generation set of challenges and opportunities. In testimony, presentations,
 19 and analyses, Mr. Klein has explored numerous aspects of these issues.
- 20 • ***Adequacy of Energy Data.*** Mr. Klein is a recognized expert on the use and misuse of coal and other
 21 energy data, particularly as they apply to modeling and forecasting efforts. He has developed new
 22 approaches toward incorporating disparate sources of information, and has been published at length
 23 on the pitfalls of using public data. For the Department of Justice, Mr. Klein directed the
 24 development of the coal reserve data base now used in DOJ's competition review procedures. He
 25 has testified as an expert witness in an intellectual property case regarding originality of methods
 26 for data collection and application in forecasting models.
- 27 • ***Federal Coal Leasing Policies.*** In several studies for public and private sector clients, Mr. Klein
 28 has evaluated impacts of leasing moratoriums, approaches to determining levels of leasing, concepts
 29 of fair market value, impacts of diligence and royalty requirements, and many other aspects of this
 30 complex regulatory program. He testified as an expert witness before the Commission on Fair
 31 Market Value Policy for Federal Coal Leasing.
- 32 • ***Transportation Policy.*** Mr. Klein has led studies evaluating impacts of rail rate deregulation,
 33 economic and energy impacts of coal slurry pipelines, railroad leasing of federal coal, coal
 34 transportation costs for different modes, and many others. In efforts with DOE, he conducted
 35 studies of the effects of the Staggers Rail Act on coal and electricity markets. He has testified before
 36 the Interstate Commerce Commission on market dominance issues.
- 37 • ***Transportation Strategies.*** Mr. Klein has worked with shippers to formulate strategies for
 38 enhancing their competitive alternatives and improving their bargaining position. Working with
 39 carriers, law firms, investment bankers, and others, he has developed market forecasts of rail traffic
 40 and revenues, analyzed impacts of economic and legislative uncertainties, and helped to develop
 41 approaches for enhancing market share and contribution.

42 **SELECTED PUBLICATIONS AND PRESENTATIONS**

43 “Progress and New Developments in CO₂ Capture and Storage” (co-authored with Robert L. Kane (DOE),
 44 Sean I. Playsynski (DOE/NETL), and Rameshwar D. Srivastava (SAIC)), presented at the 11th

- 1 Electric Utilities Environmental Conference: Air Quality & Global Climate Change, Tucson,
2 Arizona, January 29-31, 2008.
- 3 “Use of Coal Combustion Products and Implications for GHG Emissions,” presented to the EUCU
4 Conference on New Business Opportunities in Coal Combustion Products, Charlotte NC, July 16,
5 2007.
- 6 “Use of Coal Combustion Products and Implications for GHG Emissions,” presented to the Flyash Concrete
7 & GHG Reductions Workshop, Wal-Mart Sustainable Value Initiative, Durham NC, May 4, 2007.
- 8 “A Perfect Storm for Energy, National Security, & Climate,” presented to the National Hydropower 2007
9 Annual Conference, Washington DC, March 17, 2007.
- 10 “New Developments in Carbon Capture and Storage” (co-authored with Robert L. Kane (DOE), Sean I.
11 Playsynski (DOE/NETL), and Rameshwar D. Srivastava (SAIC)), presented at the 10th Electric
12 Utilities Environmental Conference: Air Quality & Global Climate Change, Tucson, Arizona,
13 January 22-24, 2007.
- 14 “Climate Change: Reporting Responsibilities under the Climate VISION Memorandum of Understanding,”
15 presented to the American Public Power Association 2006 National Conference, Chicago IL, June
16 13, 2006.
- 17 “Climate Vision, Power PartnersSM, & GHG Activities for Public Power,” presented to the American Public
18 Power Association seminar on “Climate Change: Making Community-Based Decisions in a
19 Carbon-Constrained World,” Washington DC, Feb. 28, 2006.
- 20 “New Developments in Carbon Capture and Storage” (co-authored with Sean Playsynski, DOE/NETL),
21 presented at the 9th Electric Utilities Environmental Conference: Air Quality & Global Climate
22 Change, Tucson, Arizona, January 23-25, 2006.
- 23 “Prospects for Participation of Methane Sectors in Emissions Trading Programs in California,” prepared for
24 the Center for Clean Air Policy, October 2005, [http://www.climatechange.ca.gov/documents/2005-
25 10-14_CCAP_REPORTS/CCAP_REPORT_METHANE.PDF](http://www.climatechange.ca.gov/documents/2005-10-14_CCAP_REPORTS/CCAP_REPORT_METHANE.PDF)
- 26 “Suitability of Methane Sources for Greenhouse Gas Emissions Trading,” prepared for the Center for Clean
27 Air Policy, Washington D.C. Draft report dated August 2005; report publication upcoming.
- 28 “New Developments in DOE’s Carbon Sequestration Program” (co-authored with Robert L. Kane, DOE),
29 presented at the 8th Electric Utilities Environmental Conference: Air Quality & Global Climate
30 Change, Tucson, Arizona, January 24-26, 2005.
- 31 “Climate VISION Update: Policy Drivers for Climate Change and Energy Security” (co-authored with
32 David Berg, DOE), presented at the 8th Electric Utilities Environmental Conference: Air Quality &
33 Global Climate Change, Tucson, Arizona, January 24-26, 2005.
- 34 “CCP Use and Their Impact on Greenhouse Gases,” presented to American Coal Ash Association, Canadian
35 Industries Recycling Coal Ash, Midwest Coal Ash Association, Dearborn, Michigan, June 8, 2004.
- 36 “Climate VISION & the Administration’s Global Climate Change Initiative” (co-authored with David Berg,
37 DOE), presented at the 7th Electric Utilities Environmental Conference: Air Quality & Global
38 Climate Change, Tucson, Arizona, January 20-22, 2004.
- 39 “Estimating GHG Savings from Use of Coal Combustion Products: Methodology & Results for 2000-2001”
40 (co-authored with James Roewer, Utilities Solid Waste Action Group (USWAG)), presented at the
41 7th Electric Utilities Environmental Conference: Air Quality & Global Climate Change, Tucson,
42 Arizona, January 20-22, 2004.

- 1 “DOE’s Carbon Sequestration Program and New Directions for Meeting Global Climate Change Goals”
 2 (co-authored with Robert L. Kane, DOE), presented at Combustion Canada ’03, Vancouver, British
 3 Columbia, Canada, September 21-24, 2003.
- 4 “Database of Carbon Sequestration R&D Projects in the U.S.” (co-authored with Robert L. Kane, DOE),
 5 presented at 2nd Annual Conference on Carbon Sequestration, May 5-8, 2003, Alexandria, Virginia.
- 6 “Incorporating Mortality Reductions From Use of Low-Cost Power into Evaluations of Externality
 7 Proposals,” presented at the Valuing Externalities Workshop, U.S. Dept. of Energy National Energy
 8 Technology Laboratory, Alexandria VA, Feb. 20-21, 2003,
 9 <http://www.netl.doe.gov/publications/proceedings/03/valuing-ext/Klein.pdf>.
- 10 “Mortality Reductions from Use of Low-Cost Coal-Fueled Power: An Analytical Framework,” presented at
 11 the 6th Electric Utilities Environmental Conference: Air Quality & Global Climate Change, Tucson,
 12 Arizona, January 27-29, 2003.
- 13 “DOE’s Carbon Sequestration Program and New Directions for Meeting Global Climate Change Goals”
 14 (co-authored with Robert L. Kane, DOE), presented at the 6th Electric Utilities Environmental
 15 Conference: Air Quality & Global Climate Change, Tucson, Arizona, January 27-29, 2003.
- 16 “Mortality Reductions from Use of Low-Cost Coal-Fueled Power: An Analytical Framework” (co-authored
 17 with Ralph L. Keeney, Duke University Fuqua School of Business), prepared for the Center for
 18 Energy and Economic Development, *et al.*, December 2002,
 19 <http://www.ceednet.org/kkhealth/index.asp>.
- 20 “Carbon Sequestration: An Option for Mitigating Global Climate Change” (co-authored with Robert L.
 21 Kane, DOE), published as Chapter 6 in *Environmental Challenges and Greenhouse Gas Control for*
 22 *Fossil Fuel Utilization in the 21st Century*, edited by M. Mercedes Maroto-Valer, Chunshan Song,
 23 and Yee Soong, New York: Kluwer Academic/Plenum Publishers, 2002.
- 24 “A Database of Carbon Sequestration R&D Projects in the U.S.” (co-authored with Robert L. Kane, DOE),
 25 presented at the 5th Electric Utilities Environmental Conference: Air Quality, Global Climate
 26 Change, Renewable Energy & Emergency Response, Tucson, Arizona, January 22-25, 2002.
- 27 “Carbon Sequestration: An Option for Mitigating Global Climate Change” (co-authored with Robert L.
 28 Kane, DOE), published in *Chemical Engineering Progress*, June 2001, pp. 44–52.
- 29 “Opportunities for Advancements in Chemical Processes in Carbon Sequestration and Climate Change
 30 Mitigation” (co-authored with Robert L. Kane, DOE), presented at the American Chemical Society
 31 221st Annual Meeting, San Diego California, April 4, 2001.
- 32 “Carbon Sequestration: A Third Pathway for Mitigating Global Climate Change” (co-authored with Robert
 33 L. Kane, DOE), presented at the Electric Utilities Environmental Conference, Tucson, Arizona,
 34 January 8-12, 2001.
- 35 “CO₂ Sequestration: Expanding Our Options for Mitigating Global Climate Change” (co-authored with
 36 Robert L. Kane, DOE), presented at the 93rd Annual Meeting and Exhibition of the Air & Waste
 37 Management Association, Salt Lake City, Utah, June 2000.
- 38 “Environmental Benefits of Fossil Energy Technologies and Importance for Future Carbon Mitigation
 39 Costs” (co-authored with Robert L. Kane, DOE), presented at Combustion Canada ’99: Combustion
 40 and Global Climate Change, Canada’s Challenges and Solutions, Calgary, Alberta, Canada, May
 41 26-28, 1999.
- 42 “CO₂ Sequestration: Opportunities and Challenges” (co-authored with Robert L. Kane, DOE, and Howard J.
 43 Herzog, MIT Energy Laboratory), presented at Combustion Canada ’99: Combustion and Global
 44 Climate Change, Canada’s Challenges and Solutions, Calgary, Alberta, Canada, May 26-28, 1999.

- 1 “Climate Challenge Program: Lessons Learned and Prospects for the Future” (co-authored with Daniel R.
 2 Cleverdon, Cadmus Group Inc.), presented at Combustion Canada ’99: Combustion and Global
 3 Climate Change, Canada’s Challenges and Solutions, Calgary, Alberta, Canada, May 26-28, 1999.
- 4 “Coal Mine Methane: Opportunities for Low-Cost Zero-GHG Power” (co-authored with Paul Teske,
 5 MCNIC Oil & Gas Co.), presented at Combustion Canada ’99: Combustion and Global Climate
 6 Change, Canada’s Challenges and Solutions, Calgary, Alberta, Canada, May 26-28, 1999.
- 7 “Buyer vs. Seller Liability in International Emissions Trading,” presented at the CCAP International
 8 Emissions Trading Dialog Group, Toronto, Ontario, Canada, March 4, 1999.
- 9 “Fossil Energy-Related Greenhouse Gas Control Strategies and Associated Environmental Benefits” (co-
 10 authored with Robert L. Kane, DOE), presented at the Electric Utilities Environmental Conference:
 11 Science, Regulations & Impacts of SO₂, CO₂, O₃, NO_x & Mercury, Tucson AZ, January 11-13,
 12 1999.
- 13 “Western Utilities’ Outlook for Greenhouse Gas Emissions and Options for Achieving Reductions” (co-
 14 authored with Dr. Prabhu Dayal, Tucson Electric Power Co.), presented at the Electric Utilities
 15 Environmental Conference: Science, Regulations & Impacts of SO₂, CO₂, O₃, NO_x & Mercury,
 16 Tucson AZ, January 11-13, 1999.
- 17 “Coal Mine Methane Capture in Southwestern Virginia” (co-authored with Paul Teske, MCNIC Oil & Gas
 18 Co.), presented at the Air & Waste Management Association’s Second International Specialty
 19 Conference on Global Climate Change, Crystal City VA, October 13-16, 1999.
- 20 “Global Climate Change: The Road to Kyoto,” (co-authored with C.V. Mathai, Arizona Public Service Co.,
 21 and Nikhil Desai), published in EM Magazine, a publication of the Air & Waste Management
 22 Association, November 1997.
- 23 “Managing the Climate Change Risks in a Restructuring Electric Utility Industry” (co-authored with Robert
 24 L. Kane, DOE), presented at the International Climate Change Conference & Technologies
 25 Exhibition, Baltimore MD, June 12-13, 1997.
- 26 “Voluntary Programs to Reduce GHG Emissions: Cross-National Perspectives” (co-authored with Robert L.
 27 Kane, DOE), presented at the 90th Annual Meeting and Exhibition of the Air & Waste Management
 28 Association, Toronto, Ontario, Canada, June 8-13, 1997.
- 29 “Coal Mine Methane: New Market Opportunities for Power and Gas Providers,” presented at the USEPA
 30 conference “Deregulation and New Coalbed Methane Opportunities,” Pittsburgh, PA, April 22,
 31 1997.
- 32 “Interactions Between Greenhouse Gas Policies and Acid Rain Control Strategies” (co-authored with Robert
 33 L. Kane and Larry Mansueti, DOE), presented at the Air & Waste Management Association’s Acid
 34 Rain and Electric Utilities II Conference, Scottsdale, AZ, January 21-22, 1997.
- 35 “Climate Change, Voluntary Programs, and Risk Management in a Restructuring Industry” (co-authored
 36 with Robert L. Kane, DOE), presented at the International Association for Energy Economics 11th
 37 Annual North American Conference, Boston, Massachusetts, October 28, 1996.
- 38 “United States Strategy for Mitigating Global Climate Change” (co-authored with Robert L. Kane, DOE),
 39 presented at the Third International Conference on Carbon Dioxide Removal, Boston,
 40 Massachusetts, September 9, 1996.
- 41 “Climate Challenge: Relating Electric Utility Voluntary Actions to National Goals” (co-authored with
 42 Robert L. Kane, DOE), presented at the 89th Annual Meeting and Exhibition of the Air & Waste
 43 Management Association, Nashville, Tenn., June 23-28, 1996.

- 1 “Meeting the Climate Change Challenge: Climate-Related Activities of the U.S. Department of Energy's
 2 Office of Fossil Energy” (co-authored with Robert L. Kane, DOE, and Steven Reich, ICF),
 3 presented at the 18th IAEE International Conference, Washington DC, July 5-8, 1995.
- 4 “Trends in Greenhouse Gas Emissions in the U.S. and Potential Future Outlook” (co-authored with Robert
 5 L. Kane, DOE, and Steven Winkelman, ICF), presented at the 88th Annual Meeting and Exhibition
 6 of the Air & Waste Management Association, San Antonio, Texas, June 18-23, 1995.
- 7 “The Challenge of Climate Change: A Progress Report on the Potential for Voluntary Industry-
 8 Government Partnerships to Reduce Greenhouse Gas Emissions” (co-authored with Robert L.
 9 Kane, DOE, and Nikhil Desai, ICF), presented at the 88th Annual Meeting and Exhibition of the Air
 10 & Waste Management Association, San Antonio, Texas, June 18-23, 1995.
- 11 “Further Opportunities for Coal Combustion Byproducts to Reduce Greenhouse Gas Emissions” (co-
 12 authored with Samuel S. Tyson, ACAA, and Steven Winkelman, ICF), presented at the CCB
 13 Management and Use Workshop, Memphis, Tennessee, April 17-19, 1995.
- 14 “Climate Change and New Opportunities for Coal Combustion Byproducts” (co-authored with Samuel S.
 15 Tyson, ACAA), presented at the 11th International Symposium on Use & Management of Coal
 16 Combustion Byproducts, Orlando, Florida, January 15-19, 1995.
- 17 “Full Consideration of Externalities” (co-authored with David Kathan, ICF), presented to the NARUC -
 18 DOE Fifth National Integrated Resource Planning Conference, May 1994.
- 19 “Greenhouse Gas Emission Reduction Options and Strategies” (co-authored with Robert L. Kane, DOE),
 20 presented to the Air & Waste Management Association International Specialty Conference on
 21 Global Climate Change: Science, Policy, and Mitigation Strategies, Phoenix, Arizona, April 1994.
- 22 “The Dynamic Energy & Greenhouse Emission Evaluation System (DEGREES)” (co-authored with Ira H.
 23 Shavel, et. al., ICF), presented to the 15th Annual North American Conference, International
 24 Association for Energy Economics, Seattle, Washington, October 1993.
- 25 “Carbon Taxes and Carbon Limits Are Not the Same” (co-authored with Ira H. Shavel, David J. Doyle, and
 26 Jerry L. Golden (TVA)), presented to the 15th Annual North American Conference, International
 27 Association for Energy Economics, Seattle, Washington, October 1993.
- 28 “Impacts of Including Externalities in National Electric Utility Planning” (co-authored with David Kathan,
 29 ICF), presented to the 15th Annual North American Conference, International Association for
 30 Energy Economics, Seattle, Washington, October 1993.
- 31 “Marketing Gas to Future Electricity Producers More Than Writing Purchase Orders” (co-authored with B.
 32 Venkateshwara, ICF), published in *Natural Gas*, July 1988.
- 33 “New Competition for the Railroads,” published in *The Journal of Commerce*, May 1, 1986.
- 34 “Lower Sulfur Coals as a Means of Reducing Sulfur Dioxide Emissions,” presented to the First International
 35 Conference on Acid Rain: Regulatory Aspects and Engineering Solutions, published in *Power*
 36 *Magazine*, Washington, D.C., March 1984.
- 37 “Forecasting Employment Impacts of Acid Rain Control Programs,” presented to Resources for the Future
 38 Symposium, Washington, D.C., December 1983.
- 39 “Adequacy of Low-Sulfur Coal Supplies for Meeting Acid Rain Requirements,” presented to the Air
 40 Pollution Control Association, 76th Annual Meeting and Exhibition, Atlanta, Georgia, June 1983.
- 41 “The Outlook for Coal in the Next Twenty Years” (co-authored with C. Hoff Stauffer, Jr., ICF), presented to
 42 the Electric Power Research Institute Fuels Supply Seminar, Memphis, Tennessee, December 1981,
 43 published in *Selected Papers on Fuel Forecasting and Analysis*, EPRI EA-3015, May 1983.

- 1 “Relationship of Coal and Oil Prices” (co-authored with C. Hoff Stauffer, Jr., ICF), December 1981,
 2 published in *Selected Papers on Fuel Forecasting and Analysis*, EPRI EA-3015, May 1983.
- 3 “Effects of Resource Depletion on Future Coal Prices,” presented to the Electric Power Research Institute
 4 Fuels Supply Seminar, St. Louis, Missouri, October 1982, published in *Proceedings: Fuel Supply*
 5 *Seminars*, EPRI EA-2994, March 1983.
- 6 “Coal Market Forecasts, the Clean Air Act, and Effects on Western Coal Production,” presented to the
 7 Western Interstate Energy Board, Santa Fe, New Mexico, May 1982.
- 8 “National and Regional Coal Reserves Information for Planning and Policy: The Problems,” presented to
 9 the Electric Power Research Institute Workshop on Applied Coal Geoscience and the Electric
 10 Utilities, Austin, Texas, November 1981.
- 11 “Coal Supply, Demand, and Transportation,” presented to the Coal Week/Energy Bureau Conference on
 12 Coal Transportation, Arlington, Virginia, October 1980.

13 **SELECTED REPORTS**

- 14 “Prospects for Participation of Methane Sectors in Emissions Trading Programs in California,” prepared for
 15 the Center for Clean Air Policy, October 14, 2005.
 16 [http://www.climatechange.ca.gov/documents/2005-10-](http://www.climatechange.ca.gov/documents/2005-10-14_CCAP_REPORTS/CCAP_REPORT_METHANE.PDF)
 17 [14_CCAP_REPORTS/CCAP_REPORT_METHANE.PDF](http://www.climatechange.ca.gov/documents/2005-10-14_CCAP_REPORTS/CCAP_REPORT_METHANE.PDF)
- 18 “Mortality Reductions from Use of Low-Cost Coal-Fueled Power: An Analytical Framework” (co-authored
 19 with Ralph L. Keeney, Research Professor, Duke University Fuqua School of Business), prepared
 20 for the Center for Energy and Economic Development, *et al.*, December 2002.
- 21 “Suitability of Methane Sources for Emissions Trading,” prepared for the Center for Clean Air Policy,
 22 publication forthcoming.
- 23 “Climate Challenge Program Report” (co-authored with Princeton Economic Research, Inc.), U.S.
 24 Department of Energy Publication DOE/FE-0355, December 1996.
 25 <http://www.eere.energy.gov/climatechallenge/progressreport/titlpg.htm>.
- 26 “Increased Fly Ash Use Under the Climate Challenge Program: A Summary of Participation Accords
 27 Between the Electric Utilities and the U.S. Department of Energy,” prepared for American Coal Ash
 28 Association, January, 1996.
- 29 “Economic Impacts of Climate Change Policies on TVA,” submitted to the Tennessee Valley Authority, June
 30 1993.
- 31 “Coal Combustion Waste Management Study”, submitted to Department of Energy, Office of Fossil Energy,
 32 February, 1993.
- 33 “Screening Analysis of H.R. 2663: ‘CO₂ Offsets Policy Efficiency Act of 1991’”, submitted to Department
 34 of Energy, Office of Fossil Energy, January 1992.
- 35 “Assessment of Greenhouse Gas Emissions Policies of the Electric Utility Industry: Costs, Impacts, and
 36 Opportunities,” submitted to the Edison Electric Institute, January 1992.
- 37 “Low Sulfur Coal Markets: Past and Future,” submitted to the Alliance for Clean Energy, October 1987.
- 38 “Analysis of Issues Associated with Railroad Control of Coal,” submitted to Rocky Mountain Energy, May
 39 1986.
- 40 “Analysis of Cost-Effective, Phased-In Reductions of Sulfur Dioxide Emissions,” submitted to the Alliance
 41 for Clean Energy, February 1984.

- 1 “The Effect on Producer Surplus of Increasing Coal Prices in Various Western Coal-Producing Regions,”
 2 submitted to the Department of Justice, February 1982.
- 3 “Potential Impacts of Overleasing and Underleasing of Federal Coal,” submitted to the U.S. Department of
 4 Energy, August 1981.
- 5 “An Examination of Lognormality of Coal Seam Thickness,” September 1980.
- 6 “Coal and Electric Utilities Model Documentation,” submitted to the Environmental Protection Agency,
 7 May 1980.
- 8 “Concepts and Issues in Discounted Cash Flow Analysis for Estimating Fair Market Value for Federal
 9 Coal,” submitted to the Department of Interior, April 1980.
- 10 “Coal Resource Information, Volume 3: Case Studies in Evaluating the Adequacy of Information,”
 11 submitted to the Electric Power Research Institute, EPRI EA-673 Vol. 3, March 1980.
- 12 “The Potential Energy and Economic Impacts of Coal Slurry Pipelines,” submitted to the Department of
 13 Energy, January 1980.
- 14 “Observations on Fair Market Value for Federal Coal Leases,” submitted to the Fair Market Value Task
 15 Force, Department of Interior, December 1979.
- 16 “The Demand for Western Coal and Its Sensitivity to Key Uncertainties,” submitted to the Departments of
 17 Interior and Energy, September 1978.
- 18 “Economic Considerations in Industrial Boiler Fuel Choice,” submitted to the Congressional Budget Office,
 19 June 1978.
- 20 “Energy and Economic Impacts of H.R. 13950 (Surface Mining Control and Reclamation Act of 1976),”
 21 submitted to the Council on Environmental Quality and U.S. EPA, September 1977.

22 **EXPERT TESTIMONY**

- 23 Pre-Filed Rebuttal Testimony on behalf of Otter Tail Power Company and others, regarding the price
 24 volatility of natural gas prices and the attendant effects on household income and public health, and
 25 on the potential contribution of demand-side management programs, before the Minnesota Public
 26 Utilities Commission, Case No. OAH No. 12-2500-17037-2, MPUC Dkt No. CN-05-619, and OAH
 27 No. 12-2500-17038-2, MPUC Dkt No. TR-05-1275, “In the Matter of the Application to the
 28 Minnesota Public Utilities Commission for a Route Permit for the Big Stone Transmission Project
 29 in Western Minnesota,” December 1, 2006, December 8, 2006, November 13, 2007, and January
 30 16, 2008.
- 31 Pre-Filed Rebuttal Testimony and oral cross-examination on behalf of Otter Tail Power Company, regarding
 32 the price volatility of natural gas prices and the attendant effects on household income and public
 33 health, before the South Dakota Public Utilities Commission, Case No. EL05-022, “In the Matter of
 34 the Application by Otter Tail Power Company on Behalf of the Big Stone II Co-Owners for an
 35 Energy Conversion Facility Siting Permit for the Construction of the Big Stone II Project,” June
 36 2006. <http://www.state.sd.us/puc/commission/dockets/electric/2005/el05-022/rebtestimonyklein.pdf>
 37 and <http://www.state.sd.us/puc/commission/dockets/electric/2005/el05-022/rebtestimonyyuggerudex31a.pdf>.
 38
- 39 Expert Report and oral testimony on behalf of Hill & Associates, Inc., regarding intellectual property claims
 40 concerning coal market forecasting models, before the American Arbitration Association, Case No.
 41 16 168Y 00681 05, May 2005.

- 1 Pre-Filed Rebuttal Testimony of behalf of the Center for Energy and Economic Development, regarding the
 2 human costs associated with the higher costs of replacement power, before the Public Utilities
 3 Commission of the State of California, Docket No. A.02-05-046, "Application of Southern
 4 California Edison Company (U 338-E) Regarding the Future Disposition of the Mohave Generating
 5 Station," May 2003.
- 6 Supplemental Declaration on behalf of the UMWA Health and Retirement Funds analyzing low-volatile
 7 metallurgical coal markets and market power potential, before the U.S. District Court for the
 8 District of Columbia, Joseph P. Connors, Sr. et al. v. Island Creek Corp, Drummond Coal Co., et al.,
 9 C.A. Nos. 87-1210-SSH and 87-1973-SSH, October 23, 1995.
- 10 Declaration and Deposition on behalf of UMWA Health and Retirement Funds regarding relationships
 11 between contribution rates to the Funds and coal market prices, and changes in U.S. coal industry
 12 structure, before the U.S. District Court for the District of Columbia, In re: United Mine Workers of
 13 America Employee Benefit Plans Litigation, Master File No. MDL 886, May-October, 1994.
- 14 Declaration on behalf of UMWA Health and Retirement Funds regarding relationships between contribution
 15 rates to the Funds and coal market prices, and changes in U.S. coal industry structure, before the
 16 U.S. District Court for the District of Columbia, Joseph P. Connors, Sr. et al. v. Island Creek Corp,
 17 Drummond Coal Co., et al., C.A. Nos. 87-1210-SSH and 87-1973-SSH, March 16, 1994.
- 18 Testimony on behalf of the UMWA Health and Retirement Funds regarding trends in coal production, union
 19 market shares, and sensitivity to changes in union costs, before the U.S. District Court, Western
 20 District of Virginia, Lena Pearl McGlothlin et al. v. Joseph P. Connors et al., Civil Action No. 92-
 21 0022-A, April 1, 1992.
- 22 Declaration and Deposition on behalf of the UMWA Health and Retirement Funds regarding past trends and
 23 forecasts of coal production, productivity, and labor-hours for specific companies and for all
 24 UMWA mines, in the U.S. District Court for the District of Columbia, In Re: United Mine Workers
 25 of America Employee Benefit Plans Litigation, Multidistrict Litigation No. 886 CA. No.
 26 88-0969-TH, February-March 1992.
- 27 Affidavits on behalf of Whitney Benefits Inc. relating to federal coal leasing, western coal markets, and
 28 royalty rates, before the United States Claims Court, Whitney Benefits Inc. and Peter Kiewit Sons'
 29 Co. v. United States of America, No. 499-83L, February-March, 1992.
- 30 Deposition on behalf of Chugach Alaska Corporation and subsidiaries regarding methodology and findings
 31 of coal property valuation, before the U.S. Bankruptcy Court for the District of Alaska, Case Nos.
 32 91-00207-3-DMD through 91-00211-3-DMD, August 27, 1991.
- 33 Declarations on behalf of the UMWA Health and Retirement Funds regarding trends in coal markets, mining
 34 productivity, and union status, before the U.S. District Court for the District of Columbia, Civil
 35 Actions Nos. 89-1744 and 90-0674, March 1990 - January 1992.
- 36 Deposition on behalf of Kansas City Southern Industries relating to markets for coal transportation and to
 37 the competitive viability of coal slurry pipelines, ETSI Pipeline Project et al. v. Burlington
 38 Northern, Inc. et al., Civil Action Number B-84-979-CA, U.S. District Court for the Eastern District
 39 of Texas, Beaumont Division, November 29-30, 1988.
- 40 Testimony and Verified Statements before the Interstate Commerce Commission on behalf of Consolidated
 41 Rail Corporation, relating to railroad market dominance issues, I.C.C. No. 37931S, August-
 42 November 1987.
- 43 Testimony before the Commission on Fair Market Value Policy for Federal Coal Leasing, regarding
 44 valuation concepts for federal coal leasing, September 7, 1983.

1 Testimony and Verified Statement of behalf of Consolidated Edison Company of New York, Inc. before the
 2 State of New York Department of Environmental Conservation, regarding low sulfur coal reserves
 3 and production, UPA #20-81-0020 (Ravenswood Coal Conversion) and UPA #20-81-0009 (Arthur
 4 Kill Coal Conversion), January-February 1983.

5 Testimony and Deposition on behalf of Mead Corporation regarding metallurgical coal markets in the U.S.,
 6 Mead Corporation v. Occidental Petroleum Corporation, Civil Action No. C-3-78-268, U.S. District
 7 Court for the Southern District of Ohio, November 1978.

8 Testimony before the U.S. Subcommittee on Public Lands and Resources of the Committee on Energy and
 9 Natural Resources, related to energy and economic impacts of the Surface Mining Control and
 10 Reclamation Act of 1976, May 11, 1977.

11 **EMPLOYMENT HISTORY**

12	Twenty-First Strategies, LLC	President	1995-present
13	ICF Resources Incorporated	Senior Consultant	1995-1997
14		Senior VP & Director	1988-1995
15	ICF Incorporated	Vice President	1980-1988
16		Associate—Project Manager	1975-1980
17	City of Palo Alto, California	Operations Analyst	1974-1975
18	Federal Energy Administration,	Data Analyst	1974
19	Office of Data Policy		
20	Atlanta (GA) Board of Education	Systems Programmer	1970-1973

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April 18, 2008

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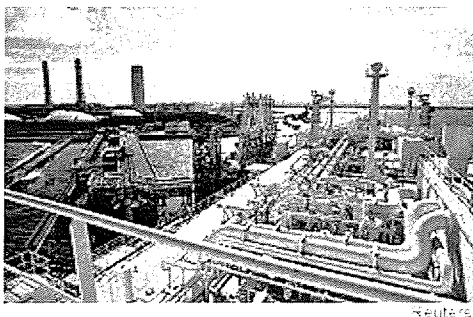
Surge in Natural-Gas Price Stoked by New Global Trade

Further Gains Likely
Despite 93% Spike;
Bidding With Japan

By ANN DAVIS and RUSSELL GOLD
April 18, 2008; Page A1

Americans feeling the pain of record gasoline prices now face the likelihood of another fuel shock, from natural gas.

Prices in the U.S. have risen 93% since late August as power-hungry nations like South Korea and Japan compete in a global natural-gas market that scarcely existed a half-decade ago. Still, U.S. prices are as low as half the level of some overseas markets, suggesting they have much further to rise.



Tokyo Electric Power Co.'s Futtsu Thermal Power Station seen from aboard the LNG Pioneer, a liquefied-natural-gas carrying ship.

The global appetite for natural gas has profound implications for a U.S. economy already tipping toward recession and struggling against inflation pressures. The fuel heats half of U.S. homes, generates 20% of the country's electricity and is used to make everything from fertilizer to plastic bags. In March, rising natural-gas prices contributed to a higher than expected 1.1% increase in producer prices, according to the Labor Department.

U.S. natural-gas output has actually been rising in recent months, and not everyone agrees that prices are destined to surge. However, a significant number of financial players are now betting on an increase.

On Thursday a report by the Barclays Capital unit of Barclays PLC warned that, partly because of rising natural-gas prices, the U.S. could start to see spikes in electricity costs in as little as a year. "Power is at the cusp of its next boom cycle," analysts said. "When power markets tighten, prices do not notch up, they skyrocket."

On Thursday, natural-gas prices on the New York Mercantile Exchange fell five cents per million British thermal units, or 0.5%, to settle at \$10.383, ending a three-day upward march. That's 33% shy of the record close of \$15.378 on Dec. 13, 2005, when a cold snap jolted the market.

What's new is the global price competition. Prior to 2003, gas was primarily a regional commodity, consumed near where it was produced and transported by pipelines. Often, it would be simply

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burned off as waste at oil wells, since transportation was so difficult.

That changed with development of cheaper methods for supercooling and transporting the fuel across the ocean in liquefied form, which requires 1/600th the space. The global trade took off.

Attracting Imports

Today, a tanker of liquefied natural gas, or LNG, pulling into port in Japan can command close to \$20 per million BTUs, roughly double the price of the U.S. benchmark. As a result, the U.S. is having trouble attracting the imports it needs to supplement homegrown production.

Last weekend, Cheniere Energy Inc. inaugurated a massive new LNG terminal on the Texas-Louisiana border capable of accommodating six tankers a week, making it the largest terminal in the U.S. However, observers expect few tankers to dock there until they can obtain higher prices for their cargo. Cheniere's stock is down 70% from its 52-week high; earlier this year, it put itself up for sale.

For the moment at least, the import slowdown means the U.S. has a glut of LNG import terminals like these. From California to New England, proposals for such facilities have faced staunch community opposition. This month New York Gov. David Paterson said the state wouldn't issue a permit for a proposed terminal in the Long Island Sound, arguing that it wasn't appropriate for the environmentally sensitive area.

Overall, U.S. imports of LNG have slid over the past nine months to a five-year low, and natural-gas inventories are running relatively low. Deutsche Bank commodities chief David Silbert says that if the U.S. is unable to attract LNG supply this summer, prices could spike up sharply within a few months if a hot summer were to reduce the ability to build a cushion of gas going into next winter.

As the odds increase that the U.S. will pass climate-change regulations that raise financial penalties for burning coal, cleaner-burning natural gas is gaining favor as the fuel to power electric plants.

Overall, gas demand from the U.S. power sector grew by 10% last year, according to the Energy Information Administration. By 2025, the U.S. could see domestic production lag demand by 15 billion to 20 billion cubic feet a day, Linda Cook, executive director of gas and power for Royal Dutch Shell PLC, told a recent energy conference.

The increased global trade in natural gas was driven partly by huge investments since 2003 in facilities to liquefy gas for export -- chilling it to negative-260 degrees Fahrenheit -- as big Western oil companies saw a business opportunity and ramped up spending on LNG infrastructure. This created economies of scale and further drove down the price of producing and shipping LNG long distances.

This triggered a revolution in gas markets. Previously, countries like Nigeria, which has ample natural gas, had no easy way to sell it due to a lack of pipelines to markets needing the fuel. Same was true for Qatar, also home to enormous gas reserves.

Early thinking assumed the globalized market would cause prices to fall because countries tight on supplies could more easily import. Former Federal Reserve Chairman Alan Greenspan, in 2003, predicted LNG would create a "price-pressure safety valve" to stabilize prices in the U.S.

Sellers With Clout

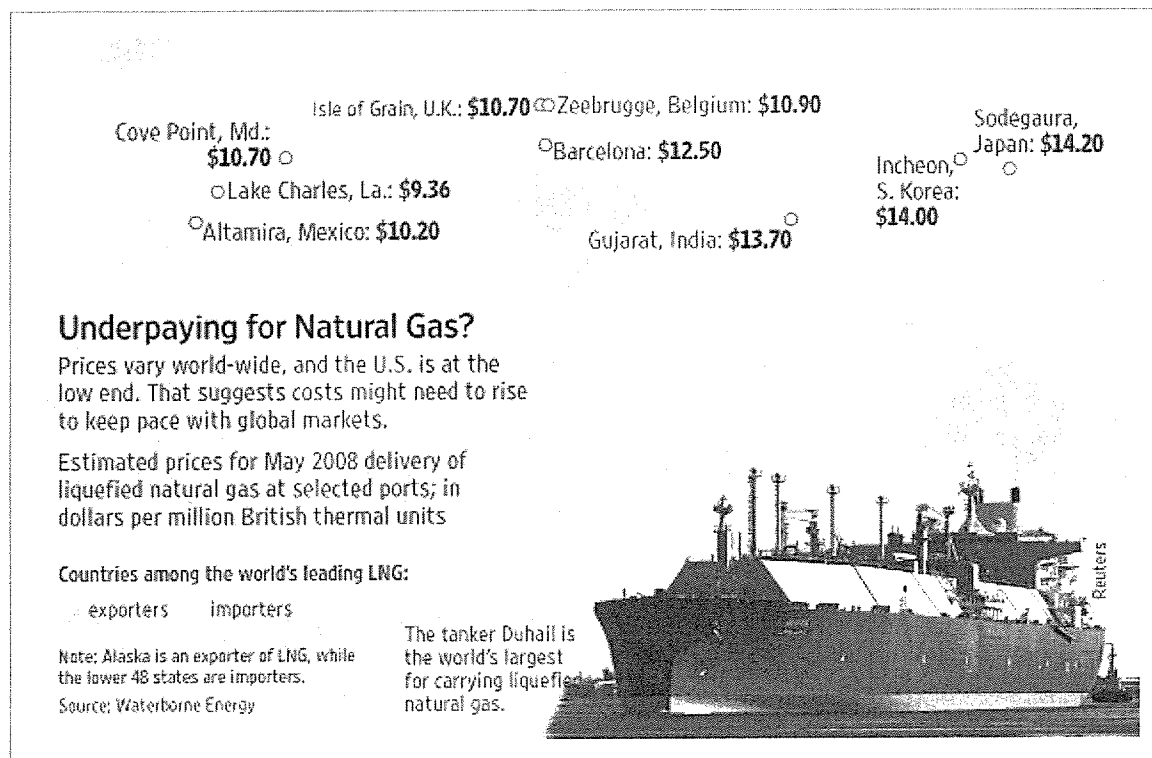
But the market is evolving differently. One key change involves the way LNG sales contracts are written. Until

recently, buyers were in the driver's seat: They were able to strike long-term deals and lock in their costs for many years. A seller like Indonesia, for instance, might have agreed to ship LNG to Japan for 10 years at relatively rigid prices.

Today, however, sellers have the clout. They are demanding that contracts be loosened to let them divert their output to markets where prices are higher. (In return they generally agree to share the profits with the customer.)

Free-for-All

This free-for-all has let suppliers shop their product to the highest bidder, adding to price volatility.



One example: When an earthquake last summer forced a massive Japanese nuclear plant to close, utilities there ramped up natural-gas use. Prices soared in Japan, which in turn drove up prices in far-off European countries, including the United Kingdom.

This kind of situation can trigger domino

effects world-wide. Late last year, the global scramble for scarce LNG worsened as a drought hit Spain, cutting its ability to use hydroelectric power. Spain normally leans on neighboring Algeria and Egypt for LNG imports - but in February those countries were busy shipping to Japan where prices were twice as high as Spain.

Turning to Trinidad

Spain turned to Trinidad for imports. But that has meant less gas for the closer -- but lower-priced -- U.S. market, which in the past has taken most of Trinidad's output. Trinidad's shipments to the U.S. through the first two months of the year are down 31% from the year-earlier period, according to government data.

Not everyone agrees U.S. natural-gas prices are certain to rise. Domestic producers such as Chesapeake Energy Corp. have made significant strides tapping into new sources of natural gas, sending U.S. gas production up 7% in January from a year earlier, to 68 billion cubic feet a day.

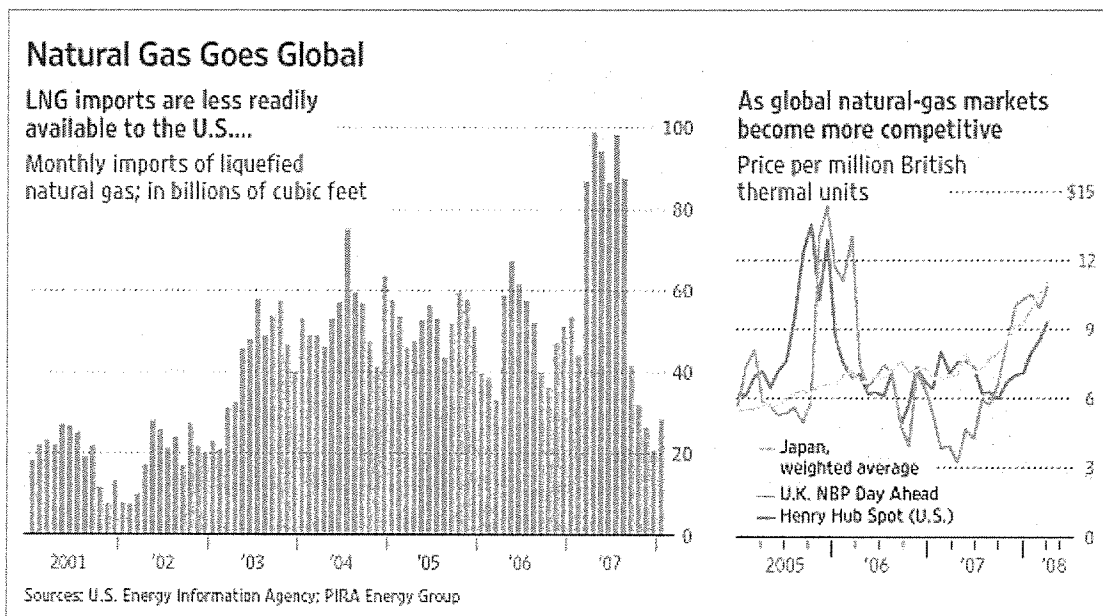
Chesapeake Chief Executive Aubrey K. McClendon sees production continuing to grow, holding U.S. gas prices between \$7 to \$10 per million BTUs and avoiding the need to increase imports. And Michael Stoppard, a senior director of energy consultant CERA, predicts world LNG supply will grow by 30% in the next two years,

making more chilled gas available for the U.S.

Nevertheless, more financial players are lining up against the bears, saying low prices won't last. They point out that, even as U.S. production increased in 2007, prices still rose 19%.

Meantime, as Asian buyers grab more LNG from the Atlantic basin, U.S. prices, though at 27-month highs, still look cheap. Energy hedge funds in Houston and New York have placed a flood of bullish bets on U.S. gas prices for delivery several years from now, say some of the traders and their Wall Street brokers.

One argument underpinning that bet: U.S. gas is far cheaper than it has historically been relative to crude oil. Until 2004, the price for a barrel of oil was roughly the same as the price of 6,000 cubic feet of gas, the equivalent amount of energy. Now oil is almost double the price of gas on that basis, Lehman Brothers analysts point out.



In a twist, the effort to build alternative-energy projects like solar arrays and wind farms also boosts construction of gas-fired plants. Because wind is unpredictable, it's often necessary to build back-up generators, and gas-fired plants have an advantage in that they can be started up relatively quickly, says Doug Kimmelman, senior partner with Energy Capital Partners, a private-equity firm focused on the power sector.

In addition, regulatory approval and construction times are shorter for gas plants than coal or nuclear. For reasons like these, new gas-fired power plants continue to be built or planned.

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