# *Sustained* **Prosperity**

A new economic paradigm for Wyoming

Wyoming State Geological Survey
Challenges in Geologic Resource Development No. 5

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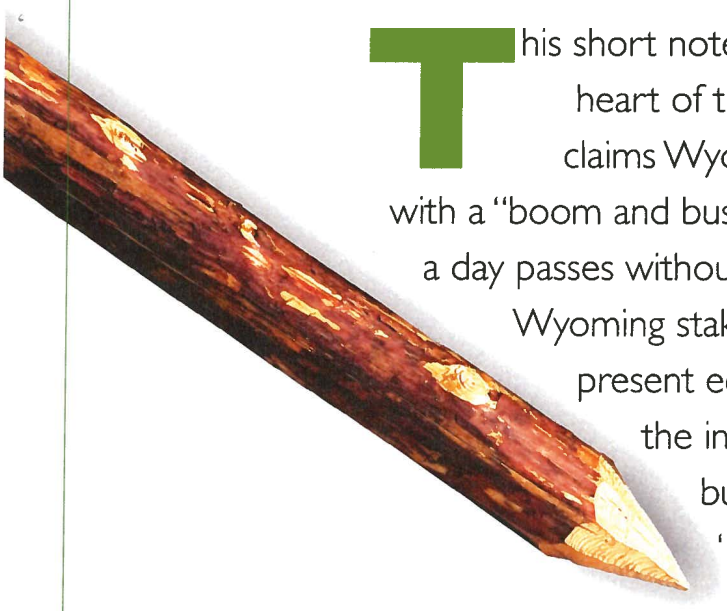

This short note drives a stake through the heart of the economic paradigm that claims Wyoming will be forever cursed with a "boom and bust" economy. It seems like not a day passes without a newspaper quote from a Wyoming stakeholder commenting on the present economic boom and lamenting the impending, inevitable economic bust. The facts suggest that this "boom and bust" paradigm for Wyoming's economy is fatally flawed and obsolete: its general acceptance across the state is one of the most significant roadblocks to planning a prosperous and optimistic future for all Wyoming residents.

The introductory statement above rests upon the following facts. The United States has 2.4% of the world's oil reserves (**Table 1**), 3.0% of the world's gas reserves (**Table 2**), and 20.0% of the world's coal reserves (**Table 3**). U.S. energy consumption increased by 10.2% from 1995 to 2005, and the country currently uses 22.2% of all the energy the world produces (**Table 4**). Demand for oil, the easiest energy commodity to transport globally, exceeded supply for the first time in 2005 (**Table 5**). At present, the U.S. consumes approximately 100 quadrillion Btu of energy each year (**Table 6**).

Over the last two decades, Wyoming has become a global energy player, thanks to its status as the number-one energy exporter to the U.S.. Many Wyoming commodities, including oil, natural gas, and coal, have played a role. Wyoming's oil production had been declining steadily (except for a minor bump during the 1980s) until 2006, when production increased slightly (**Figure 1**). This reversal was due in large part to Anadarko's successful enhanced oil recovery projects at Salt Creek and Patrick Draw (Monell unit), and to increased condensate production at Jonah and the Pinedale Anticline. Wyoming's past economic "busts" resulted primarily from significant decreases in commodity prices coupled with steady declines in production.

Oil was one of Wyoming's major energy exports – along with coal and a relatively small amount of natural gas (**Figure 2** and **Figure 3**) – until about 1990, when Wyoming's energy environment changed dramatically, rapidly, and with little warning. Coal production increased quickly and steadily, from less than 200 million tons per year in 1990 to nearly 450 million tons per year in 2006. Even without an additional rail line to transport coal out of the Powder River Basin,

**Table 1.** The world's proved oil reserves.*

| Region | Change, in billions of barrels (1995-2005) | Percent change (1995-2005) | Share of total world reserves | R/P ratio** (years) |
|---|---|---|---|---|
| North America | -29.5 | -33.1% | 5.0% | 11.9 |
| South and Central America | 20.0 | 23.9% | 8.6% | 40.7 |
| Europe and Eurasia | 59.0 | 72.4% | 11.7% | 22.0 |
| Middle East | 81.2 | 12.3% | 61.9% | 81.0 |
| Africa | 42.3 | 58.8% | 9.5% | 31.8 |
| Asia/Pacific | 1.0 | 2.6% | 3.4% | 13.8 |
| **Total** | **173.7** | **16.9%** | **100%** | **40.6** |
| United States | -0.5 | -2.0% | 2.4% | 11.8 |

**Compiled from BP Statistical Review of World Energy, June 2006.*

***Reserves to production (R/P) ratio: if the reserves remaining at the end of any year are divided by production in that year, the resulting ratio is the length of time those remaining reserves would last if production continued at that level.*

**Table 2.** The world's proved gas reserves.*

| Region | Change, in trillion cubic meters (1995-2005) | Percent change (1995-2005) | Share of total world reserves | R/P ratio** (years) |
|---|---|---|---|---|
| North America | -1.0 | -11.9% | 4.1% | 9.9 |
| South and Central America | 1.1 | 18.4% | 3.9% | 51.8 |
| Europe and Eurasia | 0.9 | 1.5% | 35.6% | 60.3 |
| Middle East | 26.8 | 59.0% | 40.1% | 100+ |
| Africa | 4.5 | 45.3% | 8.0% | 88.3 |
| Asia/Pacific | 4.3 | 40.8% | 8.3% | 41.2 |
| **Total** | **36.4** | **25.4%** | **100%** | **65.1** |
| United States | 0.8 | 18.0% | 3.0% | 10.4 |

**Compiled from BP Statistical Review of World Energy, June 2006.*

***Reserves to production (R/P) ratio: if the reserves remaining at the end of any year are divided by production in that year, the resulting ratio is the length of time those remaining reserves would last if production continued at that level.*

**Table 3.** The world's proved coal reserves.*

| Region | Change, in million tons of oil equivalent (1995-2005) | Percent change (1995-2005) | Share of total world reserves | R/P ratio** (years) |
|---|---|---|---|---|
| North America | 19.6 | 3.3% | 28.0% | 231 |
| South and Central America | 24.2 | 104.8% | 2.2% | 269 |
| Europe and Eurasia | -60.2 | -12.1% | 31.6% | 241 |
| Middle East | -0.1 | -14.3% | 0.4% | – |
| Africa | 20.9 | 17.1% | 5.6% | 200 |
| Asia/Pacific | 629.0 | 61.9% | 32.7% | 92 |
| **Total** | **633.6** | **28.1%** | **100%** | **155** |
| United States | 25.5 | 4.6% | 20.0% | 240 |

**Compiled from BP Statistical Review of World Energy, June 2006.*

***Reserves to production (R/P) ratio: if the reserves remaining at the end of any year are divided by production in that year, the resulting ratio is the length of time those remaining reserves would last if production continued at that level.*

**Table 4.** Global energy consumption (1995-2005).*

| Region | Change, in million tons of oil equivalent (1995-2005) | Percent increase (1995-2005) | Percentage of world energy consumption (2005) |
|---|---|---|---|
| North America | 294.7 | 11.8% | 26.6% |
| South and Central America | 96.2 | 25.0% | 4.8% |
| Europe and Eurasia | 203.9 | 7.3% | 28.3% |
| Middle East | 170.8 | 50.3% | 4.8% |
| Africa | 70.3 | 28.6% | 3.0% |
| Asia/Pacific | 1,112.5 | 48.1% | 32.5% |
| **Total** | **1,968.7** | **23.0%** | **100%** |
| United States | 216.9 | 10.2% | 22.2% |

**Compiled from BP Statistical Review of World Energy, June 2006.*

**Table 5.** World oil supply and demand, in millions of barrels of oil per day (MOPD).[1]

| | 2004 | 2005 | | | |
|---|---|---|---|---|---|
| | *Fourth Quarter* | *First Quarter* | *Second Quarter* | *Third Quarter* | *Fourth Quarter* |
| **Supply** | 84.08 | 83.95 | 84.52 | 83.81 | 84.03 |
| **Demand** | 84.42 | 83.92 | 82.27 | 83.04 | 85.24 |

*[1]Includes crude oil, lease condensates, natural gas plant liquids, other hydrocarbons used as refinery feedstocks, refinery gains, alcohol, and liquids produced from nonconventional sources.*

**Table 6.** U. S. energy imports and consumption.*

| **U.S. Energy Imports, 2005** | |
|---|---|
| Oil | 634.4 million tons |
| | 4,650,152,000 barrels |
| | 25.4 quadrillion Btus |
| Natural Gas | 97.0 million tons of oil equivalent |
| | 3.8 TCF |
| | 4.0 quadrillion Btus |
| Total energy imports | ~29.4 quadrillion Btus |
| **U.S. Energy Consumption, 2004** | |
| Total primary energy consumption | ~100 quadrillion Btus |

**Compiled from BP Statistical Review of World Energy, June 2006.*

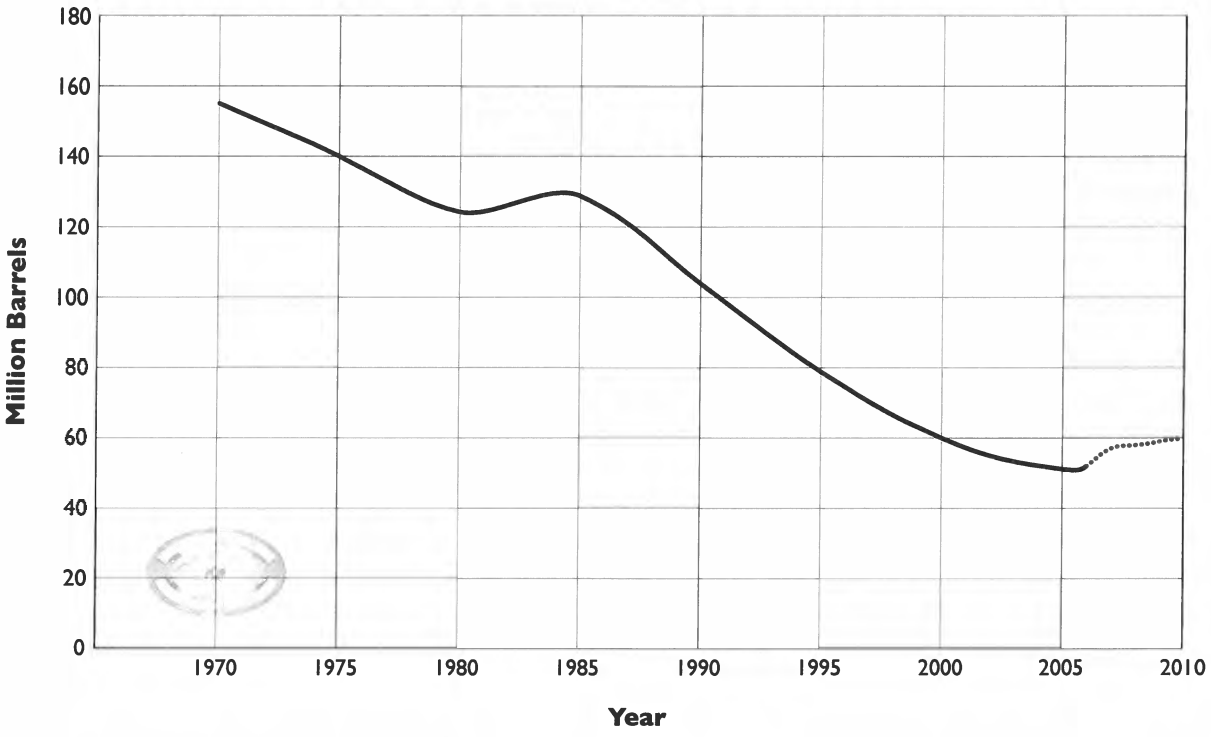


*Figure 1.* Wyoming oil production from 1970-2006. The red dotted line represents projected production through 2010.

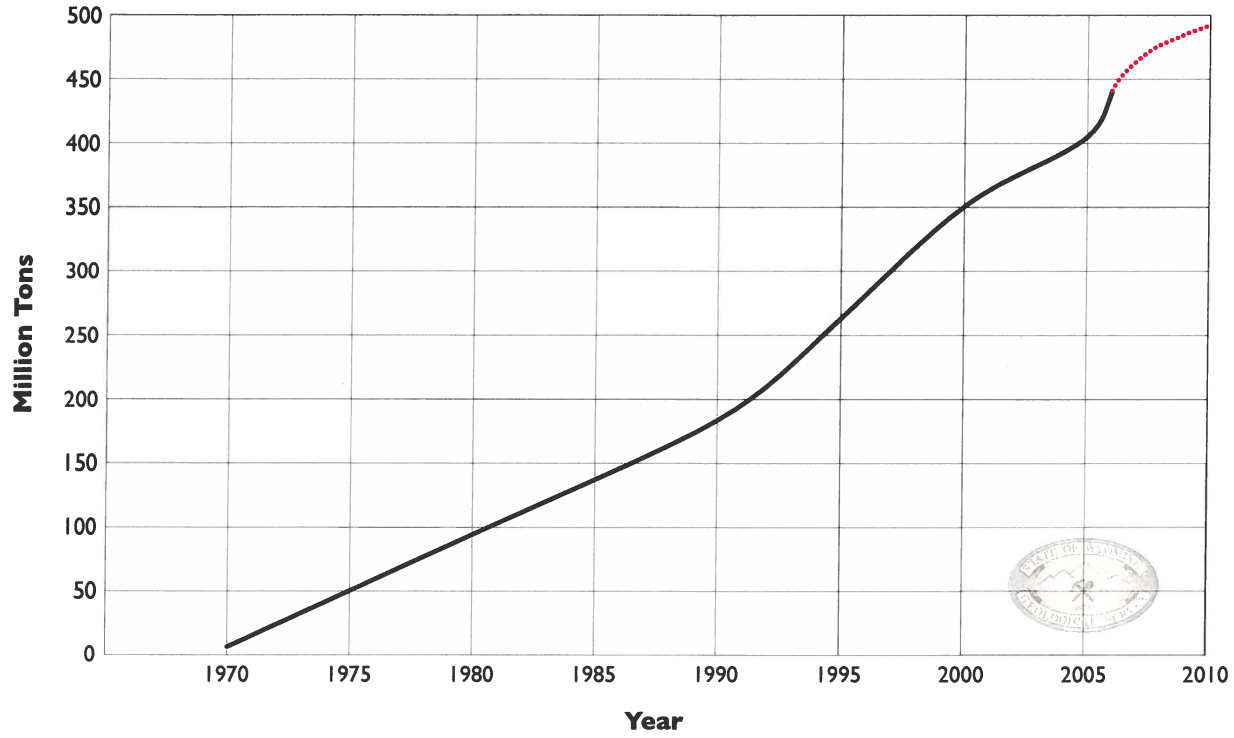


*Figure 2.* Wyoming coal production from 1970-2006. The red dotted line represents projected production through 2010.

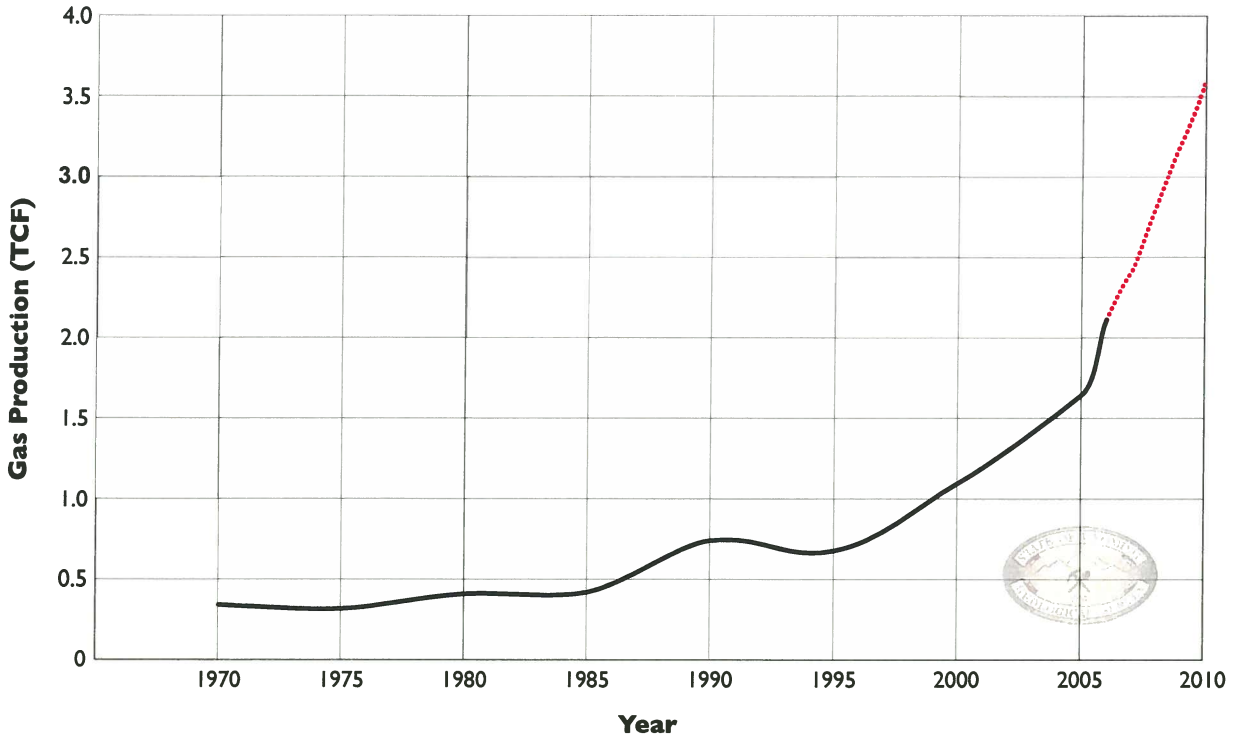


*Figure 3.* Wyoming natural gas production from 1970-2006. The red dotted line represents projected production through 2010.

Wyoming will probably produce 500 million tons of coal annually by 2010.

Natural gas production remained relatively flat (and associated mainly with oil production) until 1995. Between 1995 and 2006, Wyoming's annual natural gas production increased from little more than 0.5 trillion cubic feet (TCF) to more than 2.0 TCF (**Figure 3**). According to new well predictions by the Wyoming Oil and Gas Conservation Commission and average well performance data for the fields, Wyoming could produce as much as 3.5 TCF of gas per year by 2010.

Present constraints on oil, natural gas, and coal production include inadequate transportation, transmission lines, and pipeline capacitiy. Overcoming these constraints will require an integrated national energy plan that includes substantial upgrades of the existing, antiquated national energy infrastructure, and addition of new strategic components. This task will entail a huge public and private investment, along with an exceptional degree of cooperation.

Wyoming's energy scenario has changed drastically, rendering the "boom and bust paradigm" obsolete. During the last decade or two, Wyoming's energy portfolio has expanded and diversified. Coal and natural gas production now drive the state's economy: oil is only a minor player. Wyoming is also the nation's leading exporter of uranium.Most importantly, Wyoming has become the number-one domestic exporter of energy over the last decade, exporting more than 10 quadrillion Btus per year to the rest of the U.S. (**Figure 4**). Even more astonishing is that when compared to all other major energy exporters (such as Canada, Mexico, Venezuela, and Saudi Arabia), Wyoming emerges as the leading exporter of energy to the U.S. (**Table 7**). Over the past 18 years, Wyoming evolved from a relatively minor energy producer to the

**Table 7.** Top ten exporters of energy to the United States in 2006.

| Rank | Country or state | Crude oil | | Natural gas | | Coal | | **Total (quadrillion btus)** |
|---|---|---|---|---|---|---|---|---|
| | | *million barrels per year* | *quadrillion btus* | *trillion cubic feet per year* | *quadrillion btus* | *million tons per year* | *quadrillion btus* | |
| 1 | Wyoming | 52.93 | 0.28 | 1.75 | 1.77 | 446.74 | 7.96 | **10.01** |
| 2 | Canada | 648.97 | 3.41 | 3.59 | 3.63 | 1.49 | 0.04 | **7.08** |
| 3 | West Virginia | 1.83 | 0.01 | 0.22 | 0.22 | 152.37 | 3.91 | **4.14** |
| 4 | Mexico | 575.61 | 3.02 | 0.01 | 0.01 | 0 | 0 | **3.04** |
| 5 | Saudi Arabia | 519.40 | 2.73 | 0 | 0 | 0 | 0 | **2.73** |
| 6 | Venezuela | 416.83 | 2.19 | 0 | 0 | 3.07 | 0.08 | **2.27** |
| 7 | Nigeria | 378.51 | 1.99 | 0.06 | 0.06 | 0 | 0 | **2.05** |
| 8 | Alaska | 270.47 | 1.42 | 0.42 | 0.43 | 0 | 0 | **1.85** |
| 9 | Iraq | 201.85 | 1.06 | 0 | 0 | 0 | 0 | **1.06** |
| 10 | Angola | 187.25 | 0.98 | 0 | 0 | 0 | 0 | **0.98** |
| **Total** | | **3,253.61** | **17.08** | **6.05** | **6.12** | **603.67** | **11.99** | **35.19** |

*Note: total may not equal sum of components because of independent rounding. Coal imports include coal to Puerto Rico and the Virgin Islands.*

*Sources:* Bureau of the Census, U.S. Department of Commerce, *Monthly Report IM 145*
EIA, *U.S. Natural Gas Imports by Country*
EIA, *U.S. Crude Oil Net Imports by Country*
EIA, *Gross Heat Content of Coal Production, Most Recent Annual Estimates, 1980-2006*

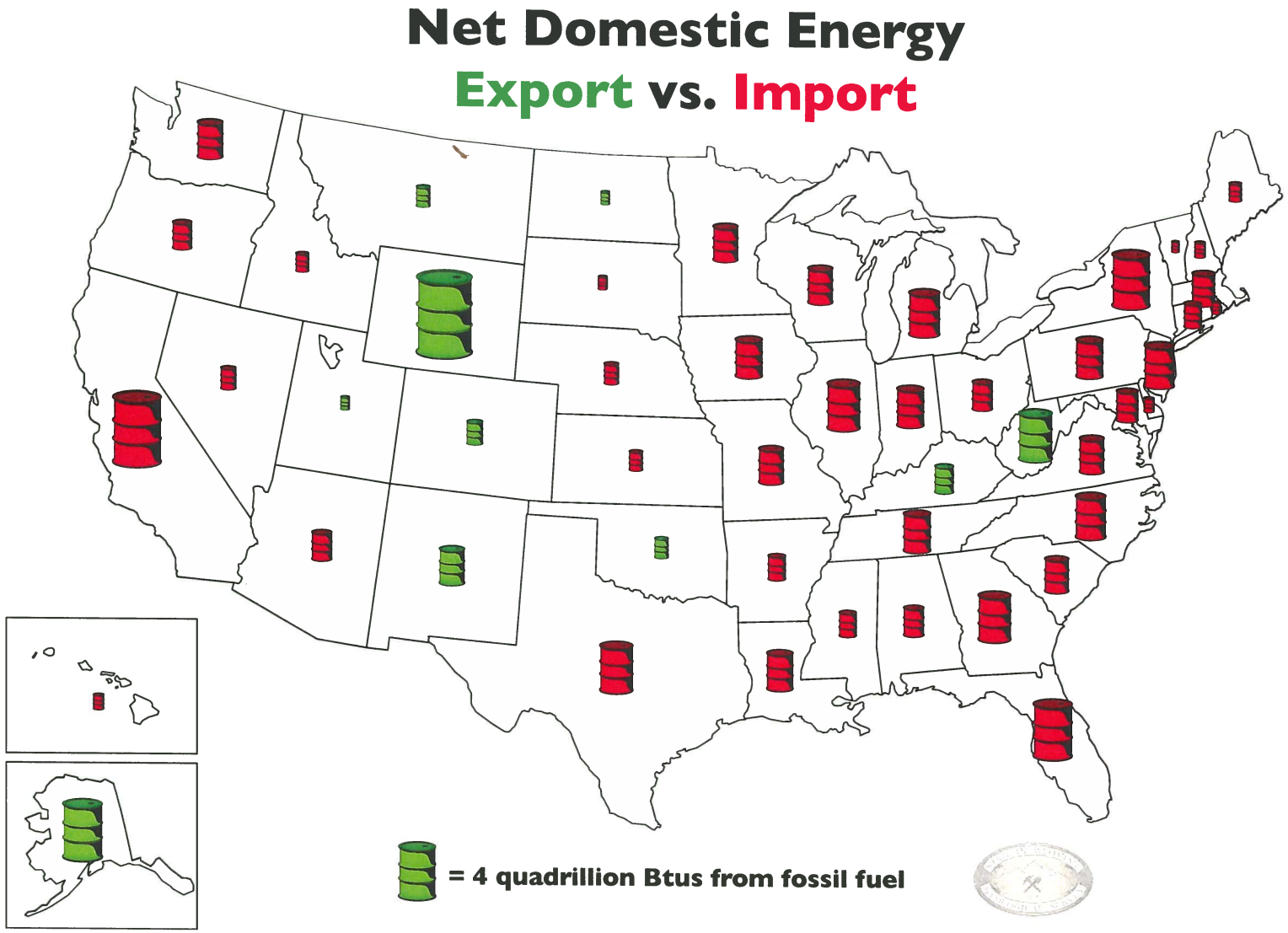


*Figure 4.* Map showing net energy balance for every state in the U.S.. Red barrels indicate a negative net energy balance (states that import energy), while green barrels indicate a positive net energy balance (states that export energy).

leading exporter of energy to our nation. Today, one out of every ten Btu used in the U.S. comes from Wyoming. Since 1970, the state's energy portfolio has gone from including a single commodity (oil) to encompassing a diverse array of energy resources characterized by steadily increasing production. In 25 years, with upgrades of transportation, pipeline, and transmission line infrastructure, Wyoming could produce 650 million tons of coal and 3.5-4.0 TCF of natural gas annually.

Given the facts presented above, and barring a global economic depression, how could anyone predict an economic bust for Wyoming? On the contrary, it is possible that Wyoming's economy could expand dramatically. In the event of a real national energy crisis, the current constraints on energy production in Wyoming could be removed, allowing the state to maximize production.

To maintain the national economic growth rate that we have all enjoyed for decades, the U.S. requires slightly more than a 1% per year increase in electric power generation, or 25-30% more electrical generation capacity over the next 25 years. In other words, to grow successfully through 2030, the U.S. will need to build 80 new conventional coal-fired power plants the size of the Jim Bridger plant, 13 large natural gas-fired power plants, 5 nuclear power plants, and 75,000 wind turbines, or some other equivalent combination of power sources (**Figure 5**).

How is our nation reacting to this electrical power crisis? In the last 15 months, 61 new power-generating projects with a combined capacity equivalent to more than 15 Jim Bridger plants have been cancelled (**Figure 6**). Washington's inability to pass a viable energy policy and draft a coherent, definitive strategy to regulate $CO_2$ emissions has caused investors to pull funding for coal-fired power plants. As a consequence,

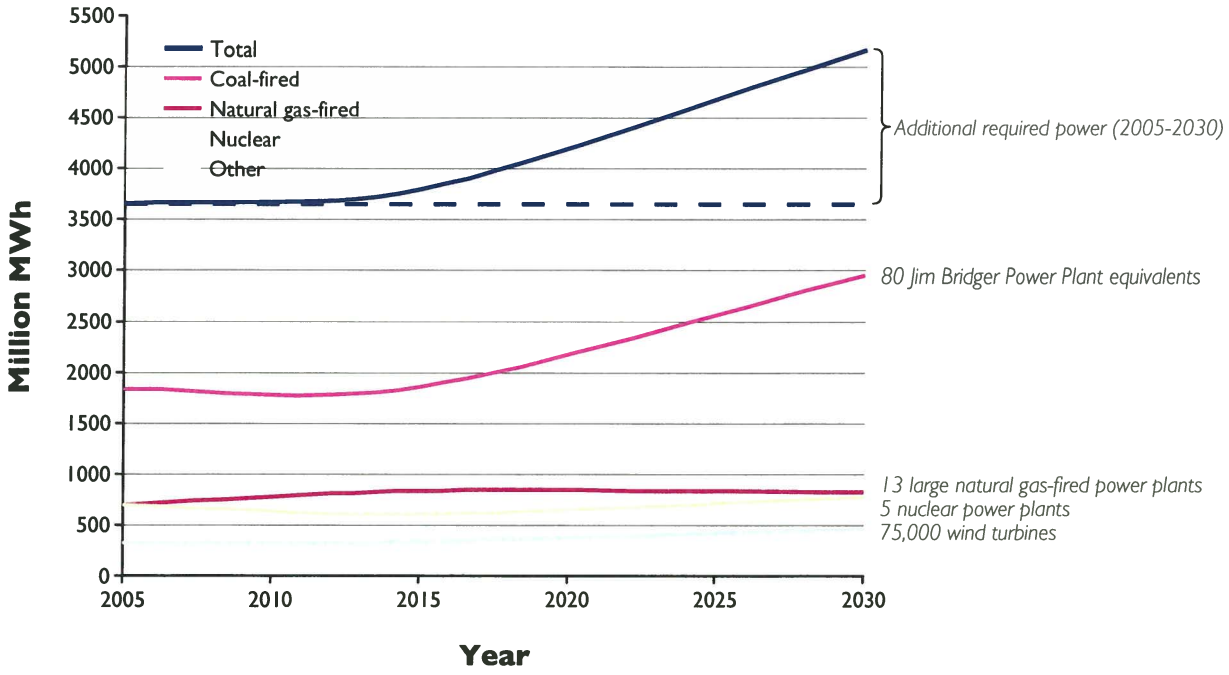


*Figure 5.* U.S. electrical power generation outlook for 2030. From the Department of Energy's Energy Information Administration *Electric Power Annual 2006* (November 2006). <http://www.eia.doe.gov/electricity/epa/epa_sum.html>.

*Figure 6.* Across the country, 61 power plant projects with a combined capacity of 31,977 megawatts (MW) have been cancelled due to the current political and regulatory uncertainty surrounding $CO_2$ emissions. Each power plant on the map corresponds to one cancelled plant in that state. *Data: sourcewatch.org and cmnow.org.*

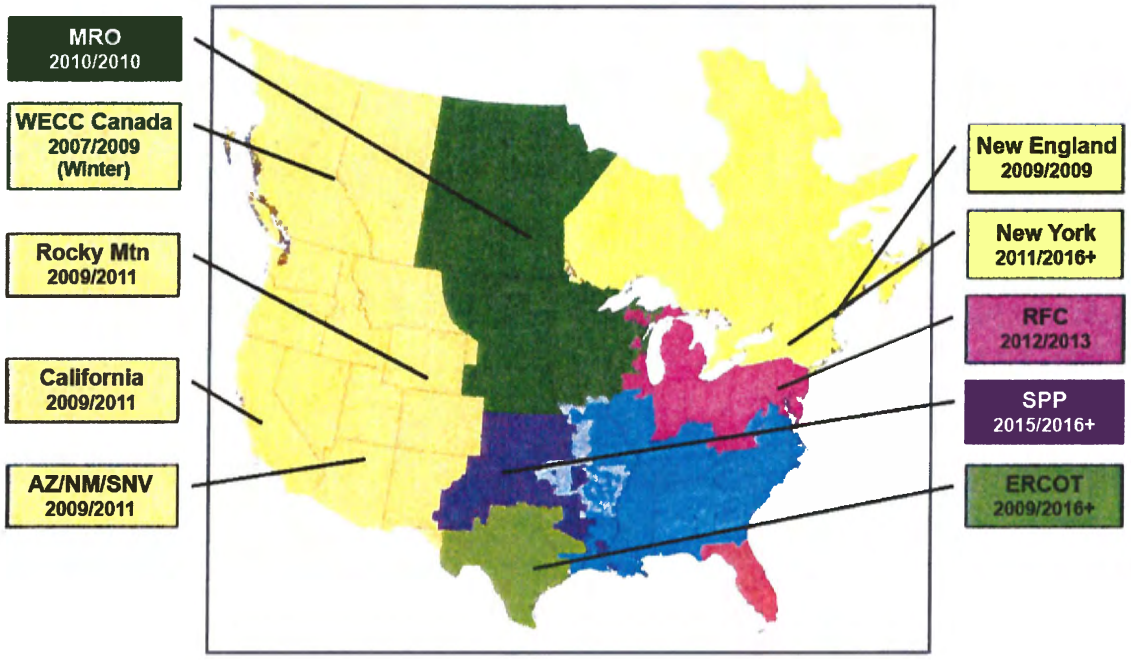


*Figure 7.* North American Electric Reliability Corporation long-term reliability assessment 2007 map, showing dates for potential "rolling brownouts." Modified from NERC LTRA 2007 by NETL.

the NERC predicts that, in the near future, the U.S. will face an unreliable electric grid and the possibility of rolling brownouts (**Figure** 7).

The logical question is: how long would it take to build the cancelled plants along with the additional power plants required to meet the nation's need for the next 25 years? These additional facilities could consist of conventional plants, $CO_2$ capture-ready plants, plants that can capture and sequester $CO_2$, and/or some other technology that meets as-yet-unspecified standards and regulations designed by congressional lawmakers. Because of severe steel and cement shortages in the U.S. (**Figure 8**), it is difficult to envision how our nation can construct essential power-generating facilities (coal-fired, gas-fired, nuclear, and wind) in less than ten years, and perhaps even in less than 20 years.

Under this scenario, or indeed under any 25-year national energy scenario, the value of Wyoming's diverse and plentiful energy resources can only significantly increase. To alleviate energy shortages in the U.S., it makes sense to look to those providers that have the capacity to supply additional energy. Wyoming is one of very few states with the capacity to significantly increase energy and power production in a relatively short time period. Under any of the national energy scenarios that have been presented by various experts, think-tanks, and government entities, Wyoming will play a central role in providing energy to the nation. Consequently, there will be intense pressure on Wyoming over the next 25-30 years to further develop its natural resources.

Instead of worrying about "boom and bust" economic cycles, Wyoming stakeholders would be much better off developing a plan to maximize the responsible development of our energy resources, the quality of our communities, and the protection of our environment. There is no economic bust in sight: Wyoming should plan for sustained prosperity.

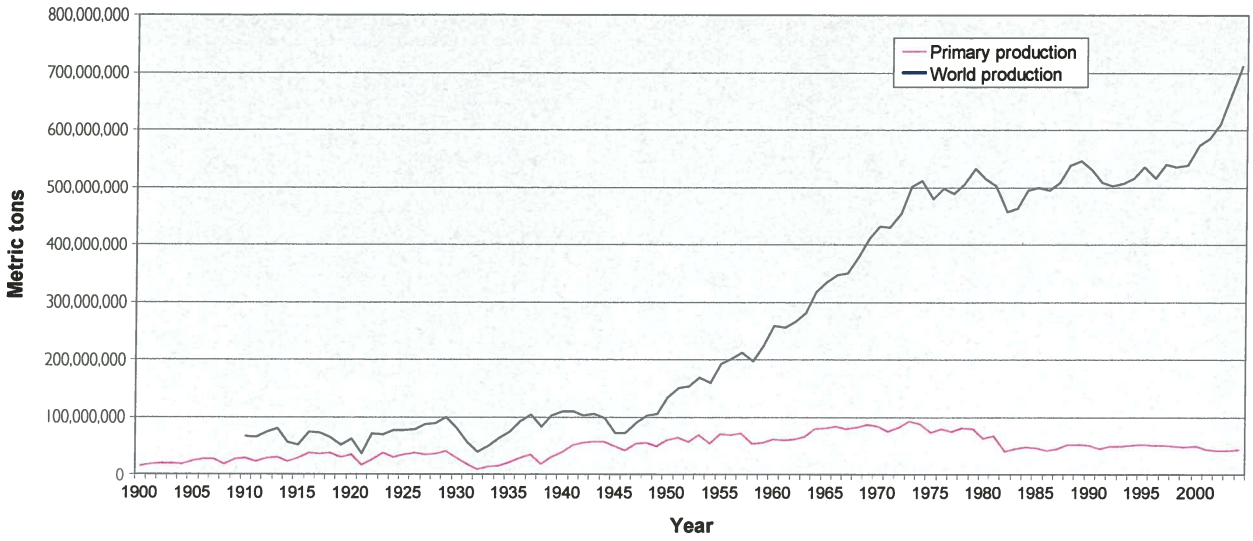


*Figure 8.* Global steel production (blue line), and U.S. primary steel production (pink line). From the USGS Mineral Commodity Summary (2006), <http://minerals.usgs.gov/minerals/pubs/mcs>.