

Natural gas supply/demand: Then, now and tomorrow

From shortage to surplus and back to a possible shortage, the natural gas industry has made planning troublesome. Here's a view on what is in store long-term

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Twenty years ago the United States government was dealing with a gas shortage. That problem was solved by reducing the demand for gas. Elsewhere in the world, production of gas was, and continues to be, limited by demand. The new factor is serious concern about the environment, which produced the Kyoto Protocol.

In 2001, production and consumption of natural gas in the world was approximately 2,523 billion cubic meters (bcm) or 89 Tcf. A comparison with earlier history is shown in Table 1.

United States. Production of crude oil in the U.S. peaked in 1970 and has since declined by 40%. The peak for natural gas followed in 1973 with 617.9 Bcm (21.8 Tcf) of marketed production. During the growth phase of the U.S. industry, the first transoceanic shipment of liquefied natural gas (LNG) was made in 1959 from Louisiana to England. A liquefaction plant and terminal at Kenai, Alaska, began operating in 1969 with exports to Japan.

In 1968, amid signs of an impending gas shortage in the lower 48 states, the Federal Power Commission (FPC) approved construction of a terminal near Boston to receive LNG from Algeria. In 1971, the FPC approved construction of terminals near Washington, D.C., and Savannah, Ga., to import over 10.3 Bcm (363.6 Bcf) per year from Algeria. In 1977, after the gas shortage had arrived, the FPC approved construction of a fourth terminal at Lake Charles, La.

Carter energy plan. In 1978, Congress finally acted to implement the Carter administration's energy plan. The certainty of the continuing decline in U.S. production was the basis of the plan. Legislation included:

- Natural Gas Policy Act (NGPA)—a complicated system of higher regulated prices for gas production
- Power plant and Industrial Fuel Use Act (FUA)—prohibited the building of new plants to use gas or fuel oil
- Public Utilities Regulatory Policies Act (PURPA)—fostered cogeneration of steam and electricity to reduce demand for gas.

In 1980, Congress passed the Crude

Oil Windfall Profits Tax to reduce "obscene profits" in production of oil. Section 29 of that law allowed credits—against the expected increases in taxes—for production of gas from coalbeds, shale, tight formations and other "unconventional" sources.

With regard to production, the Carter energy plan, and those that followed, did not work well. Despite higher prices and the tax subsidy, marketed production in the U.S. in 2001 was about what it was in 1981, and nearly 11% less than production in 1973.

The effects on gas demand, by contrast, were spectacular. In reaction to higher prices, residential, commercial and industrial users improved efficiency. Electric utilities built a large number of plants to use coal, lignite and nuclear fission.

Gas bubble. By the end of the Carter administration, demand had been reduced by more than the decline in supply. The term "gas bubble" evolved to reconcile the belief in long-term declining supply with short-term market reality. Because of alternative markets in Europe, the LNG trade with Algeria was an early casualty of the gas bubble. In 1979, U.S. imports of LNG were 7.6 Bcm (268.3 Bcf). In 1980, the terminals near Washington and Savannah were closed. In 1981, per Table 1, imports of LNG were only 1.1 Bcm (38.8 Bcf) versus exports to Japan of 1.4 Bcm (49.4 Bcf).

The bottom of the abyss for gas consumption turned out to be 485 Bcm (17.1 Tcf) in 1986—almost 24% less than 1973 consumption. In 1985—as the distress among producers and pipeline companies increased—the Reagan administration learned that the U.S. had a vast resource of undiscovered gas. Enron Corp. and the Bureau of Economic Geology at the University of Texas were prominent in the "new" science that the basis for the energy plan was wrong.

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Table 1. World gas balances, billion cubic meters (Bcm)

	1981	2000	2001
Marketed production			
United States	545.8	551.4	549.8
Canada	72.3	183.3	189.7
Europe	710.9	1,025.4	1,025.6
Asia/Oceania	74.0	267.7	272.3
Middle East	50.2	215.1	225.3
Latin America	68.0	131.9	133.4
Africa	30.6	124.2	127.2
Production	1,551.8	2,499.0	2,523.3
Trade between continents—by ship			
Africa to Europe	6.7	31.6	31.2
Middle East to Asia	2.6	21.1	28.1
Africa to US	1.1	1.6	2.9
Latin America to US	—	3.2	3.2
US to Asia	1.4	1.8	1.8
Middle East to US	—	1.8	1.0
Middle East to Europe	—	0.9	1.9
Latin America to Europe	—	0.8	0.4
Asia to US	—	0.2	0.1
Trade between continents—by pipeline			
Africa to Europe	—	33.0	32.2
Consumption and stocks			
United States	569.8	650.9	653.2
Canada	48.0	88.8	91.7
Europe	717.6	1,091.7	1,091.3
Asia/Oceania	78.0	290.4	302.1
Middle East	47.6	191.3	194.3
Latin America	68.0	127.9	129.8
Africa	22.8	58.0	60.9
Total	1,551.8	2,499.0	2,523.3

Source: CEDIGAZ and estimates

Table 2. Nuclear plant construction

Country	Name/ Location	Type	Capacity, MW
Argentina	Atucha 2	PHWR	692
Brazil	Rio de Janeiro	PWR	1,229
China	Tianwan 1	PWR	1,000
	Tianwan 2	PWR	1,000
	Ling Ao1	PWR	950
	Ling Ao2	PWR	950
	Qinshan 3	PHWR	610
	Qinshan 4	PHWR	665
India	Tarapar 3	PHWR	450
	Tarapar 4	PHWR	450
Iran	Bushehr	PWR	950
Japan	Hamaoka 5	BWR	1,257
	Shika 2	BWR	1,304
	Higashidori	BWR	1,067
	Onogawa 3	BWR	796
North Korea	KEDO 1	PWR	1,000
	KEDO 2	PWR	1,000
South Korea	Ulchin 5	PWR	950
	Ulchin 6	PWR	950
	Yonggwang 5	PWR	950
	Yonggwang 6	PWR	950
Taiwan	Lungmen 1	ABWR *	1,300
	Lungmen 2	ABWR *	1,300

* Design certified by Nuclear Regulatory Commission of United States

Table 3. World gas balances, billion cubic meters (Bcm)

	2000	2010	2020
Marketed production			
United States	551.4	380	300
Canada	183.3	185	155
Europe	1,025.4	970	850
Asia/Oceania	267.7	466	610
Middle East	215.1	365	540
Latin America	131.9	186	248
Africa	124.2	178	197
Production	2,499.0	2,730	2,900
Trade between continents—by ship			
Africa to Europe	31.6	37	30
Middle East to Asia	21.1	35	45
Africa to US	1.6	13	17
Latin America to US	3.2	4	5
US to Asia	1.8	1	—
Middle East to US	1.8	2	3
Middle East to Europe	0.9	3	7
Latin America to Europe	0.8	2	3
Asia to US	0.2	2	5
Trade between continents—by pipeline			
Africa to Europe	33.0	38	40
Consumption and stocks			
United States	650.9	475	350
Canada	88.8	110	135
Europe	1,091.7	1,050	930
Asia/Oceania	290.4	500	650
Middle East	191.3	325	485
Latin America	127.9	180	240
Africa	58.0	90	110
Total	2,499.0	2,730	2,900

The new order. It took a while for that gospel to prevail. By 1988, there were enough converts that the FUA was repealed. The NGPA was already gone, for all practical purposes. Deregulation of gas prices—which finally happened on Jan. 1, 1993—was hardly noticed.

In 1990, Congress amended the Clean Air Act and effectively shut down most construction of new coal-fired power plants. By applying excessive regulation, the Nuclear Regulatory Commission (NRC) had already done the same for nuclear fission. Construction of new natural-gas-fired power plants became the thing to do rather than being a violation of law.

Gas imports by pipeline from Canada—not LNG—were the primary means of supplying the increasing U.S. demand for gas after 1986. The limits of that process were essentially reached in 2000. The U.S. is now in the “second coming” of LNG with 7.2 Bcm (254.2 Bcf) of imports in 2001—not quite back to the 1979 volume of 7.6 bcm (268.3 Bcf).

International considerations. During the growth phase of the U.S. industry prior to 1973, demand limited production. That continues to be the situation today in most of the rest of the world.

Because it is expensive to move, compared with liquids or solids, natural gas is essentially a regional business. For energy-intensive industry, the preferred alternative is to locate plants near the source of gas. It is no accident that the refining and petrochemical industries in the U.S. are located on its Gulf Coast.

LNG transportation works well over short-haul routes, such as North Africa to Europe or Indonesia and Australia to Japan and South Korea. It is analogous to using ferries in places where bridges are not feasible for one reason or another. But over long-haul routes, LNG is a questionable proposition because of the costs involved.

Whether the “second coming” of LNG to the U.S. will fare better than the first remains to be seen. It is clear that it will be encouraged by construction of liquefaction plants and terminals in Nigeria, Norway and Australia. The major factors that will ultimately determine the result are U.S. energy policy, the Kyoto Protocol and limits to nuclear fission.

Current U.S. energy policy is to rely on natural gas for electricity generation on the way to consumption of 850 Bcm (30 Tcf) per year. As the idea that growth in domestic production will be adequate to meet supply is seen to be ridiculous, the energy plan is gradually morphing

into large volumes of imported LNG—at expected low prices.

Kyoto Protocol. The 1997 protocol in Kyoto, Japan, resulted from the personal intervention of Vice President Al Gore. It calls for industrialized countries to reduce emissions of carbon dioxide (and other “greenhouse gases”) by an average of 5% below 1990 levels and no later than by 2012. Developing countries are exempt.

The protocol has now been accepted by 70 countries. Russia is likely to make the total 71 this year. The U.S., Canada and Australia have refused. It took President Bush less than three months in office to do so—both because of his view that “carbon dioxide is not a pollutant” and because it makes no sense to exempt developing countries.

In 2001, U.S. consumption of coal was nearly 20% higher than it was in 1990. Oil consumption was a little over 15% higher. Consumption of natural gas is up close to 19%.

The science of “global warming” is uncertain. It can be observed that those of the world who want their governments to “do something” about the weather also want action about a host of other problems, real or imagined. The Bush administration and others would rather

not have the problem of trying to prove a negative—either that there is no harm being done by increasing combustion or that doing something will not help much.

Nuclear fission. Construction of nuclear-powered generation plants around the world is summarized in Table 2. In the debate over energy policy, Vice President Cheney actually observed in a town hall session that nuclear fission is the obvious way to avoid emission of greenhouse gases and that “it’s one of the safest industries in the county if you look back over the last twenty years.”

It is actually more than 22 years since the March 1979 accident at Three Mile Island Plant 2 in Pennsylvania. A milestone was passed in 1996 when a federal judge granted summary dismissal for the last lawsuit. From beginning to end, no one could ever prove injury from the small amount of radiation that escaped the plant during the accident.

In the hysteria that followed, the critical action by NRC was allowing argument-over-design of a nuclear plant in the hearing for a license to operate it at the end of construction. In May 1989, NRC changed the rules to make whether or not the plant is built as designed the

only question in granting the license to operate it. The litigation over the change ended in victory by NRC during 1992.

In 1997, NRC approved two generic designs for reactors to eliminate arguments over safety in the process for a construction license. Outside the U.S., typical practice is to build several plants with the same design—just as gas producers drill the same type well many times to develop a coalbed or tight formation. Two plants with General Electric’s ABWR design have since been built in Japan and two more are under construction in Taiwan. Two plants with Westinghouse’s APWR design have been ordered by the Japan Atomic Power Co. As yet, there are no orders for the AP600 design by Westinghouse, which NRC approved in 1999.

In June of this year, the U.S. House finally went beyond the “not in my backyard” problem with a 306-to-117 vote to approve Yucca Mountain as the site for a spent nuclear fuel storage facility over the objections of the governor of Nevada. On July 9, the Senate also approved it by a vote of 60 to 39.

Slowly, but more surely, the U.S. is moving toward reviving its use of nuclear fission. The odds are good that

the next plant will be built at Clinton, Ill., next to an existing plant.

The future. As an extension of the historical gas balance, the future should look something like Table 3. Over time, petrochemicals and other energy-intensive industry can be expected to migrate from North America and Europe to Asia, the Middle East, Africa and Latin America. That trend, along with declines in production, should make it fairly easy to achieve the targets of the Kyoto Protocol, at least in the case of natural gas. In total, however, natural gas will continue to be a growing business with production limited by demand. wo

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