

# Future Natural Gas Supply

## Keeping Up with the Natural Gas Revolution

America's natural gas industry is experiencing perhaps the most profound changes seen in forty years. Over the past decade, this veritable upheaval has been enabled and facilitated in large part by home-grown technological breakthroughs, particularly the application of horizontal and multilateral drilling and multistage hydraulic fracturing. These advancements have allowed industry to tap vast deposits of gas- and oil-bearing and -sourcing shales and other unconventional reservoirs either not previously recognized or, if known, not readily amenable to exploitation.

The result?—

- New scenarios for resource exploration, development and production (revitalizing legacy fields as well as opening new fields);
- New opportunities for infrastructural expansion to accommodate the increased output (processing, storage, transportation and distribution); and
- New marketing strategies focused on expanded use of domestic natural gas for power generation and petrochemical feedstock, but potentially also for vehicle fuel and even export (as LNG) into overseas markets.

Among the economic, regulatory, land-use, public policy and other challenges attendant with this revolu-

## About the Potential Gas Committee

Since its founding in the early 1960s and continuing to the present time, the sole purpose of the Potential Gas Committee has been to organize and train geological scientists, engineers and others for the timely and regular preparation and dissemination of assessments of the technically recoverable natural gas resource base of the United States. Except for 1974, the PGC has prepared and published these assessments on a biennial basis since 1964.

The Committee consists of knowledgeable, highly experienced volunteer members who work primarily in the natural gas exploration and production, transportation and distribution industries. The Committee also benefits from the input of respected technical advisors as well as observers from government agencies, academia, and industry and research organizations.

Although the PGC functions independently as an incorporated nonprofit entity, the Potential Gas Agency at the Colorado School of Mines provides the Committee with technical guidance, training and administrative support, and assists in member recruitment and public outreach efforts. The Agency receives financial support from E&P and gas pipeline companies and distributors, as well as industry trade and research organizations.

For further information about the Potential Gas Committee, its publications and corporate sponsorship opportunities, please contact:



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Visit the new PGC website at <http://www.potentialgas.org>

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The magnitude of resources varies from year to year, of course, but the strong upward trend in assessments over the last ten years or so reaffirms the PGC's conviction that the United States possesses an abundant natural gas resource base that can be responsibly developed for the long-term benefit, enjoyment and security of the nation's consumers.

## Report of the Potential Gas Committee

The PGC's latest biennial report tabulates assessments of potential resources for all 90 provinces within six areas of the Lower 48 U.S. and within Alaska. Each area summary includes a detailed table of all province-level assessments (by onshore drilling-depth interval and offshore water-depth interval; traditional resources and coalbed gas resources); graphs summarizing all area-level assessments ("most likely" values) of traditional and coalbed gas resources from 1984 through 2012 and mean values of traditional resources from 1990 through 2012; highlights of recent field developments; a colorful index map of sedimentary basins and assessed provinces; province-level synopses of gas potential, source rocks, reservoir rocks and traps; and stratigraphic charts indicating gas-productive and potentially productive formations. Supplemental chapters detail the PGC's assessment methodology, committee membership.

Beginning with its 2011–12 biennial report, which was released in April 2013, the PGC has returned to a shorter, more concise document than the large, loose-leaf notebook binders that had been published since 1998. The "value-added" chapters of those larger books—appearing under the general themes of *Historical Trends*, *North American Perspectives* and *Frontier Gas Resources*—will no longer be printed. Instead, selected discussions will be posted to the PGC's new website on a more occasional basis.

EIA's proved reserves of 305 Tcf (for year-end 2010, the latest value available at the time of PGC's publication) and PGC's potential resources gives a Future Supply of 2,688 Tcf, a record high value and more than double the 986 Tcf determined in 1988 (Fig. 2).

Taking this example one step further, we can derive what the PGC refers to as the *Ultimately Recoverable Resource*, or the sum of our Future Gas Supply and the volume of gas that already has been produced.

Summing 2,688 Tcf of Future Supply and 1,226 Tcf, the approximate cumulative total of gas production reported from the late 1800s through 2012, yields an Ultimately Recoverable Resource of 3,914 Tcf, also more than double that determined in 1988 (Fig. 2).

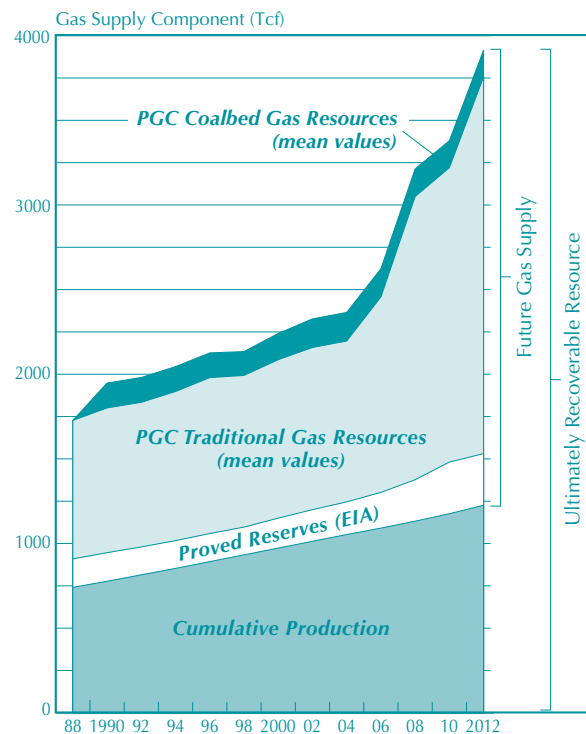


Figure 2. Determination of Future Gas Supply and Ultimately Recoverable Resources, 1988–2012.

tion is the continuing fundamental need to determine, to the best of our abilities, just how much natural gas is available to satisfy future consumer demand. The gas industry's extraordinary pace of progress dictates that we draw on a rapidly expanding stream of new geological, geophysical and engineering knowledge and on experiences gained from the field in order to regularly evaluate, quantify and, ideally, expand our potential future gas supply base.

Out of the vast, finite but largely unknown volume of natural gas that geologists believe exists *in place* within all reservoirs, we attempt to determine the smaller, finite volumes of gas that can be *recovered* now and in the future with existing and foreseeable technologies but with no implications of any specific market prices, which can be notoriously volatile over the short term and unpredictable at best over the medium term and beyond.

How then do we determine recoverable supplies out of this finite but mostly unknown resource base? Think of supply as simply the sum of two components—*potential resources* and *proved reserves*.

Potential resources include volumes of technically recoverable gas that have been *discovered* in known fields, onshore and offshore, but not confirmed or proved, together with *undiscovered* volumes believed to exist in both productive and untested formations in known fields and in postulated new fields. Changes in resource assessments from year to year arise mainly from the evaluation of new exploration ventures, drilling programs, formation and well test results and other field and technology developments. Resource assessments in recent years overall have climbed markedly as a result of the unprecedented scale of shale gas (and liquids) development.

Proved reserves, on the other hand, are those volumes from the discovered resource base that have been

*confirmed* through drilling and testing to be producible under current economic and operating conditions. As reported by the Energy Information Administration (EIA), proved reserves may increase or decrease from year to year depending on industry's success in discovering new productive reservoirs and new fields as well as extending the limits of existing fields. Note that E&P companies strive to "prove up" or replace enough additional new reserves each year to compensate for the volume of gas that is produced for consumers. Industry first achieved consistent 100%+ replacement of production with annual reserves additions—that is, discoveries plus revisions—during the decade 1993–2002. Amazingly, annual reserves replacement through new discoveries alone now have topped 200%, thanks again largely to shales.

## Role of the Potential Gas Committee

Having now identified the components of future supply, how do we assess the potential gas resource? Many researchers, analysts and decision-makers in the gas industry, as well as consulting, technical and financial services companies, rely on the work of the Potential Gas Committee, a diverse group of volunteer geologists, engineers and other experts who prepare assessments of the nation's potential gas resources. PGC's members have intimate knowledge of the geology and day-to-day status of exploration and production activities in the regions they analyze because many of them work in these same areas in the course of their professional employment.

The PGC publishes its assessments biennially and is the only scientifically based group that does so with such regularity. This dedicated, long-standing commitment—since 1964—adds not only a strong dimension of timeliness to the Committee's results, but also continuity, consistency, objectivity and thus credibility.

## Categories of Potential Gas Resources

For each of 90 defined onshore and offshore geological provinces within seven geographical assessment areas, PGC members, in their best judgment, develop a "distribution" of values (*minimum*, "*most likely*" and *maximum*) for each of three categories of technically recoverable resources—*Probable* (discovered), *Possible* (undiscovered) and *Speculative* (undiscovered), in decreasing order of geological certainty and supply assurance.

Assessments are prepared separately for "traditional" gas resources (that is, within conventional, tight and shale reservoirs) and for coalbed gas resources. Traditional resource assessments include separate evaluations for two onshore drilling-depth intervals (above and below 15,000 ft) and, where appropriate, for three offshore water depths corresponding to the outer continental shelves (0–200 m) and the upper and lower continental slopes (200–1,000 m and >1,000 m). The province-level "most likely" values are summed arithmetically to derive area- and national-level onshore and offshore subtotals for each resource category and for the area, Lower 48 U.S. and Total U.S. grand totals.

While many find the "most likely" values useful for analysis and planning purposes, the Committee has, since 1988, also computed area and national "mean" values of traditional resources by statistical aggregation of the province-level distributions within each resource category. Area and national total mean values are derived by separate aggregation of all the province distributions together, rather than by arithmetic summation of the three category mean totals. Coalbed gas resources are aggregated only at the national level. This methodological approach imparts greater statistical validity to the Committee's assessments and allows for more direct comparison of them with those prepared on a less frequent basis by other organizations.

## Resource Assessment of the Potential Gas Committee

In its latest biennial compilation, *Potential Supply of Natural Gas in the United States (December 31, 2012)*, the Potential Gas Committee has assessed a total potential gas resource of 2,384 trillion cubic feet (Tcf, mean value) for the U.S. This total consists of 2,226 Tcf in "traditional" reservoirs (conventional, tight and shale) and 158 Tcf in coalbeds (Fig. 1). This assessment marks the fourth consecutive record-high resource evaluation by the Committee in its history to date. These increases are attributable mainly to re-evaluation of shale gas resources in the Atlantic, Gulf Coast, Mid-Continent and Rocky Mountain areas.

Using the PGC's assessments, we now can quantitatively evaluate our Future Gas Supply. Summing

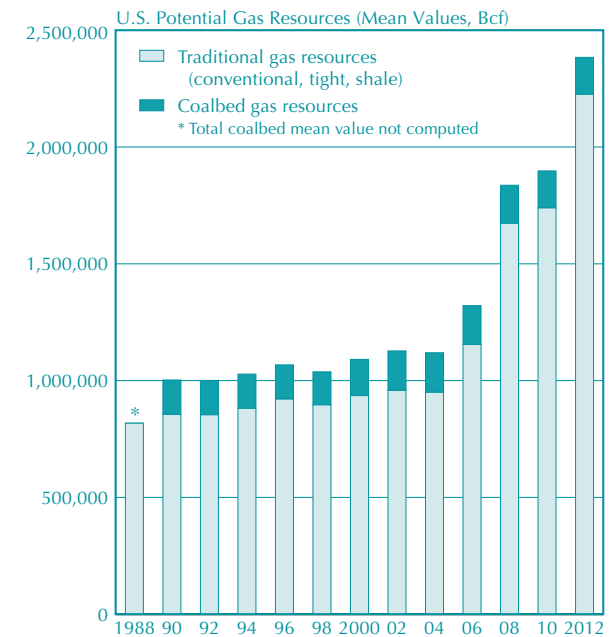


Figure 1. Potential Gas Committee assessments of U.S. potential gas resources, 1988–2012.