Shale Gas Dominates U.S. Gas Resources

Results From PGC Assessment of the Future Gas Supply

Potential Gas Committee

Potential Gas Agency
Colorado School of Mines, Golden, CO 80401-1887

RMAG Luncheon, Denver, January 3, 2018

Executive Summary

- Potential Gas Committee (PGC):
  - Non-profit group of ~80 volunteer geoscientists and engineers.
  - Biennial assessments of technically recoverable U.S. natural gas endowment since 1964.
- Assessment as of year-end 2016 (mean values):
  - 2,817 Tcf of total U.S. technically recoverable gas resources:
    - 302 Tcf or 12% increase over the previous year-end 2014 assessment.
    - Shale gas resources (1,797 Tcf) account for 64% of total gas resources.
  - Total U.S. future gas supply (reserves+resources) stands at record 3,141 Tcf.

Organization

Potential Gas Committee (PGC)

~80 volunteers

Ronald J. Kelley
President/General Chairman

Natalie H. Reagan
Chairman of the Board

- Recruits personnel and supervises work
- Develops assessment policy and procedures
- Directs and manages studies of gas resources
- Prepares reports on natural gas resources

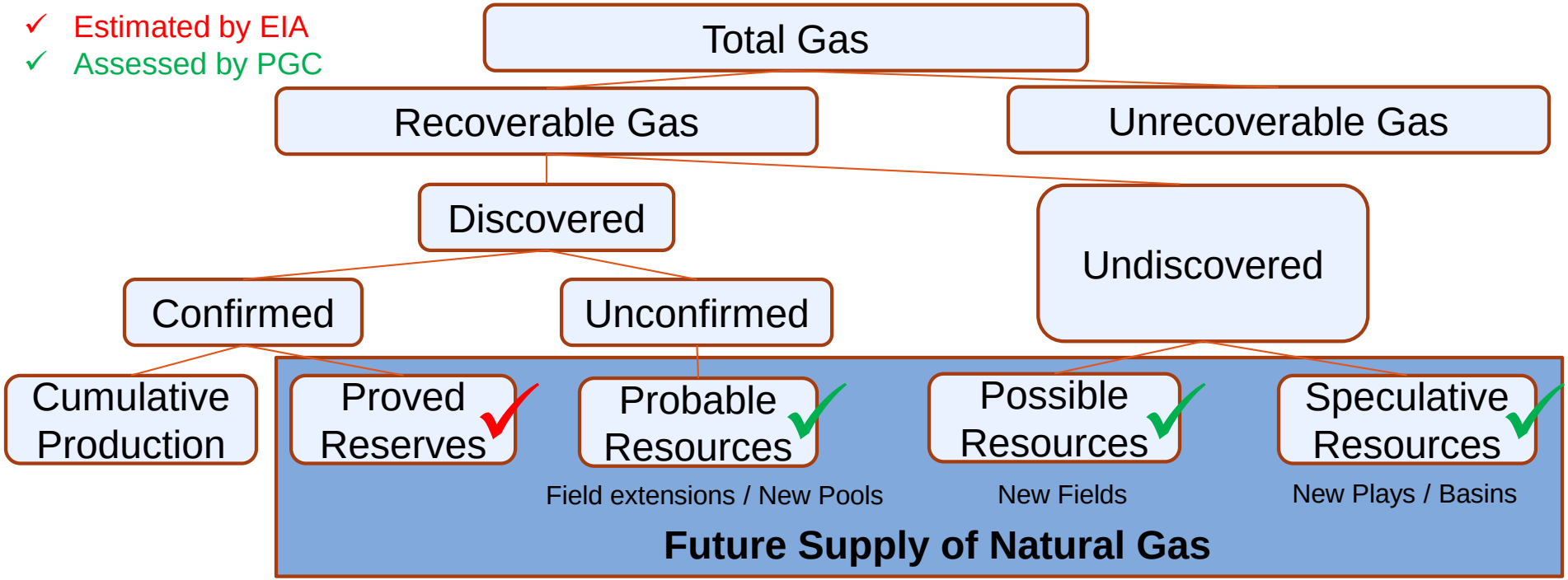
Potential Gas Agency (PGA)
Colorado School of Mines

Supported by industry

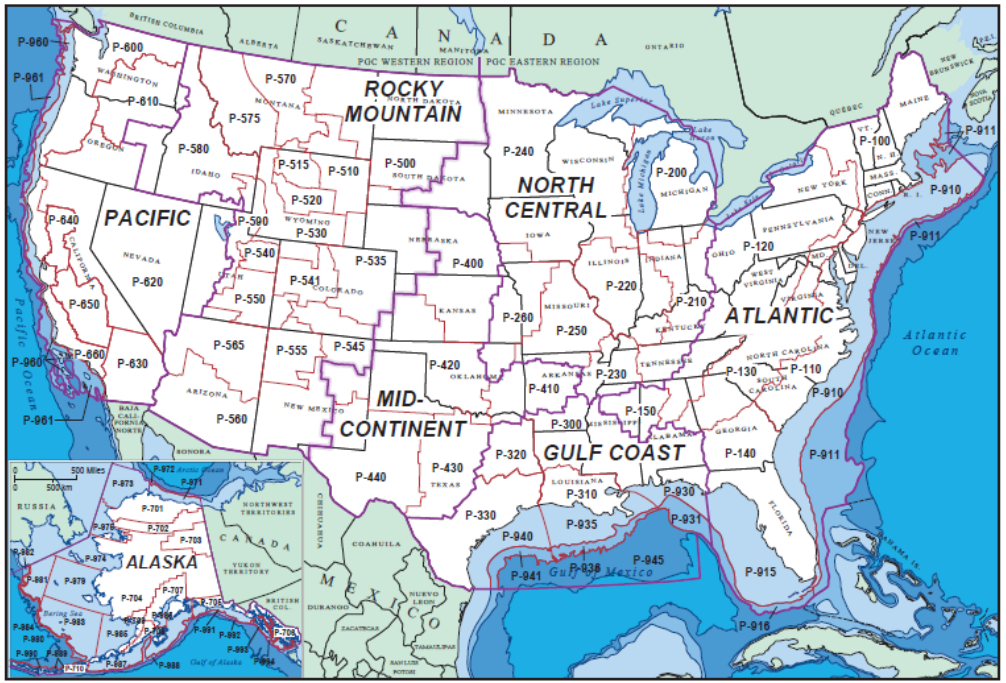
Dr. Alexei V. Milkov
Director

- Approves criteria and methods
- Ensures maintenance of standards and objectivity
- Reviews and evaluates reports
- Publishes final assessments of gas resources

PGC assesses future supply of natural gas



7 PGC work areas and 90 geologic provinces



- Settings:
  - Onshore
  - Offshore
- Depth intervals:
  - Shallow (0-15,000 ft.)
  - Deep (15,000-30,000 ft.)
- Reservoir types:
  - Traditional:
    - Conventional and tight
    - Shale gas
  - Coalbed gas (CBM)

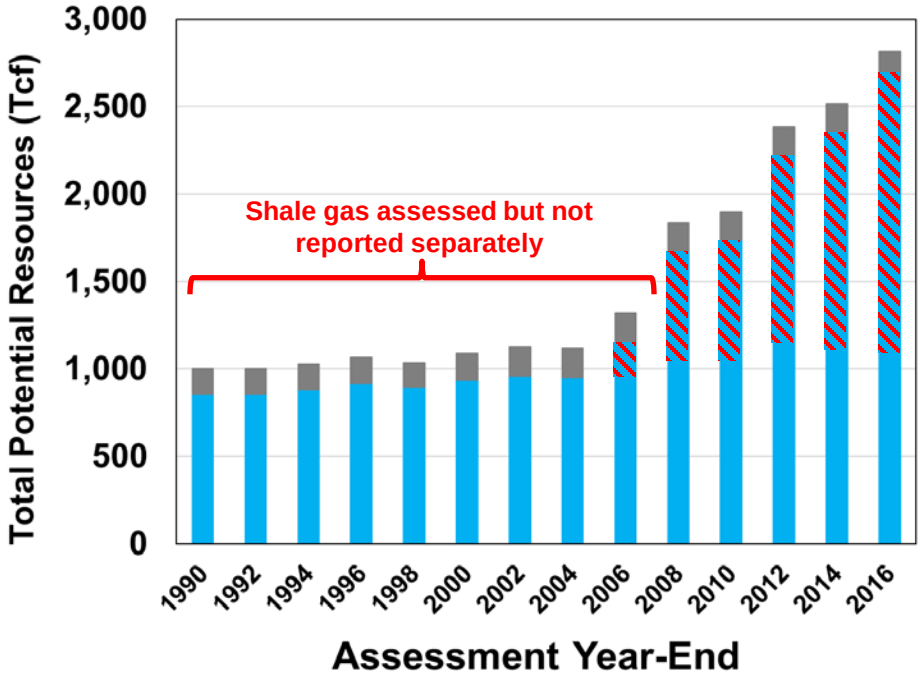
PGC resource assessment methodology

- Province-level assessments:
  - Publically-available data.
  - Individual expert judgement by practicing geoscientists and engineers.
  - Group discussions and peer-reviews.
  - Minimum – Most Likely – Maximum resource values for each province.
- Area-level assessments:
  - Statistical aggregation of province-level assessments to calculate Mean resources values.
- National-level assessment:
  - Statistical aggregation of area-level assessments to calculate mean Grand Total resources for the U.S.
  - Mean values for different types of reservoirs and different resource categories.
  - Addition of EIA's latest published proved reserves (year-end 2015) to calculate future gas supply.

Year-end 2016 assessment results

	Mean Technically Recoverable Volumes (trillion cubic feet or Tcf)
Traditional gas resources (conventional, tight and shale reservoirs)	2,658.3
Coalbed gas resources	158.7
Total gas resources	2,817.0
Proved gas reserves (EIA, year-end 2015)	324.3
Future gas supply in the U.S.	**3,141.3**

PGC gas resource assessments, 1990-2016



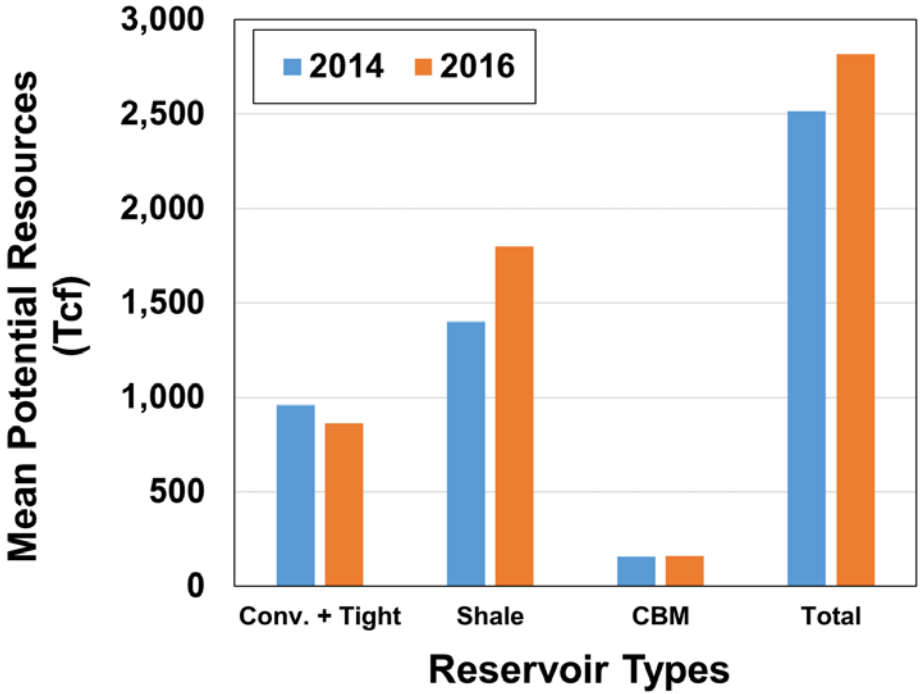
Coalbed gas resources (mean values)

Shale gas within Traditional resources (most likely values)

Traditional gas resources: conventional, tight, shale (mean values)

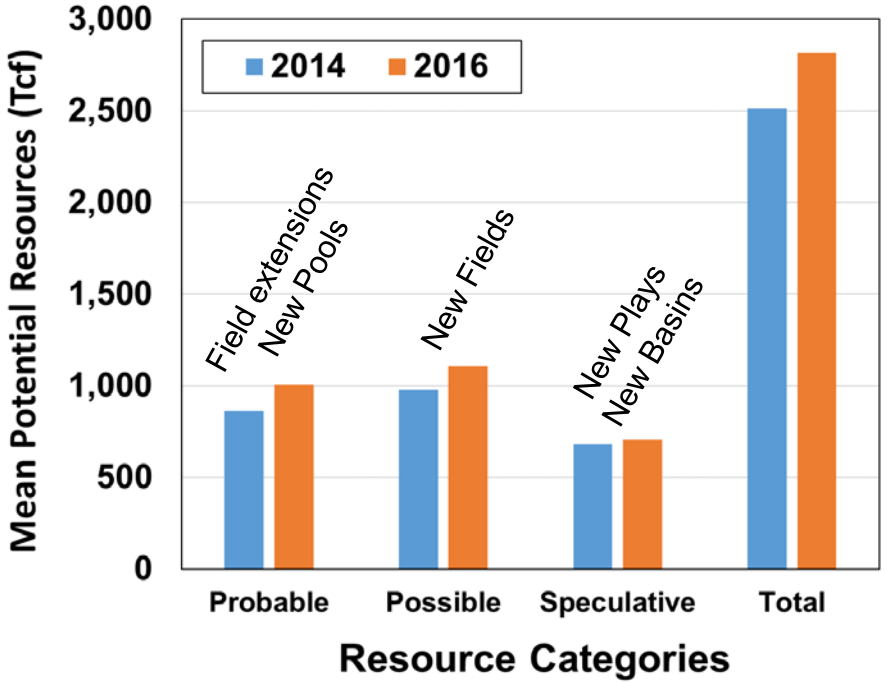
- Continuous growth of gas resources.
- Shale gas is responsible for recent increase in gas resources.

Change in gas resources relative to 2014: Reservoir types



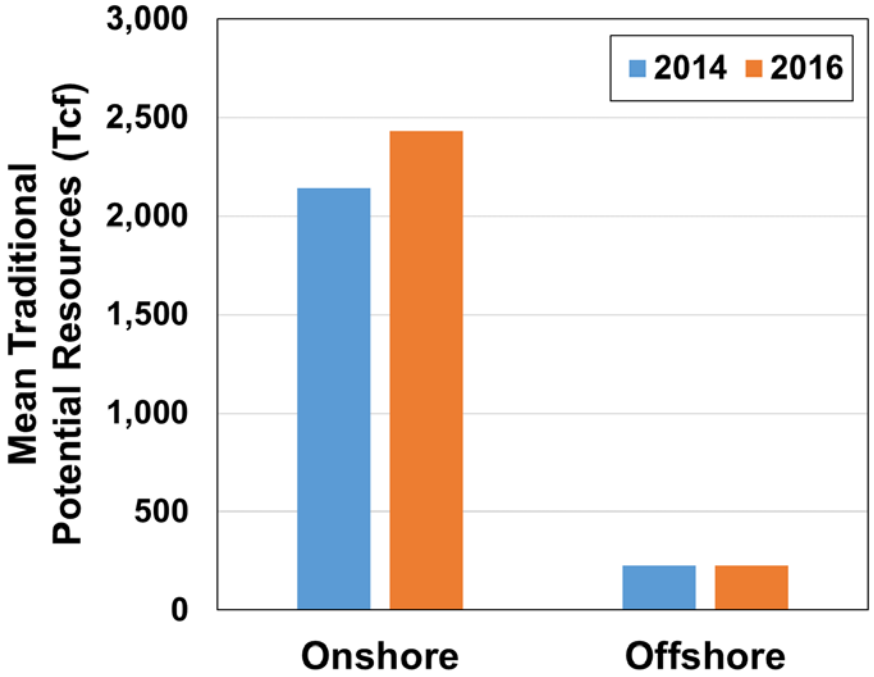
- Reduction of gas resources in conventional and tight sand/carbonate reservoirs (97 Tcf or 10%).
- Significant increase in shale gas resources (399 Tcf or 29%).
- Coalbed (CBM) resources are flat.
- Total mean potential gas resources increase of 302 Tcf or 12%.

Change in gas resources relative to 2014: Resource categories



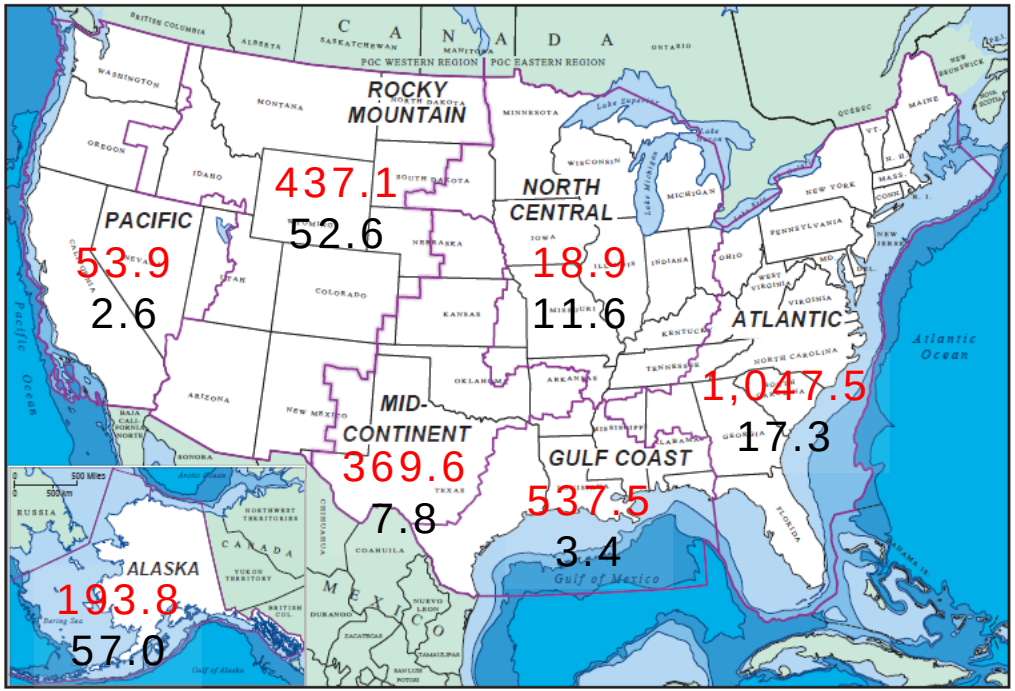
- Resources increased in all categories.
- Probable and Possible resources increased significantly, reflecting continuous development of established plays.
- Little growth of Speculative resources due to limited frontier exploration.

Change in Traditional gas resources from 2014: Onshore vs Offshore



- Traditional resources:
  - Conventional and tight reservoirs
  - Shale reservoirs
- Significant increase in Onshore gas resources (290 Tcf or 14%).
- No change in Offshore gas resources.

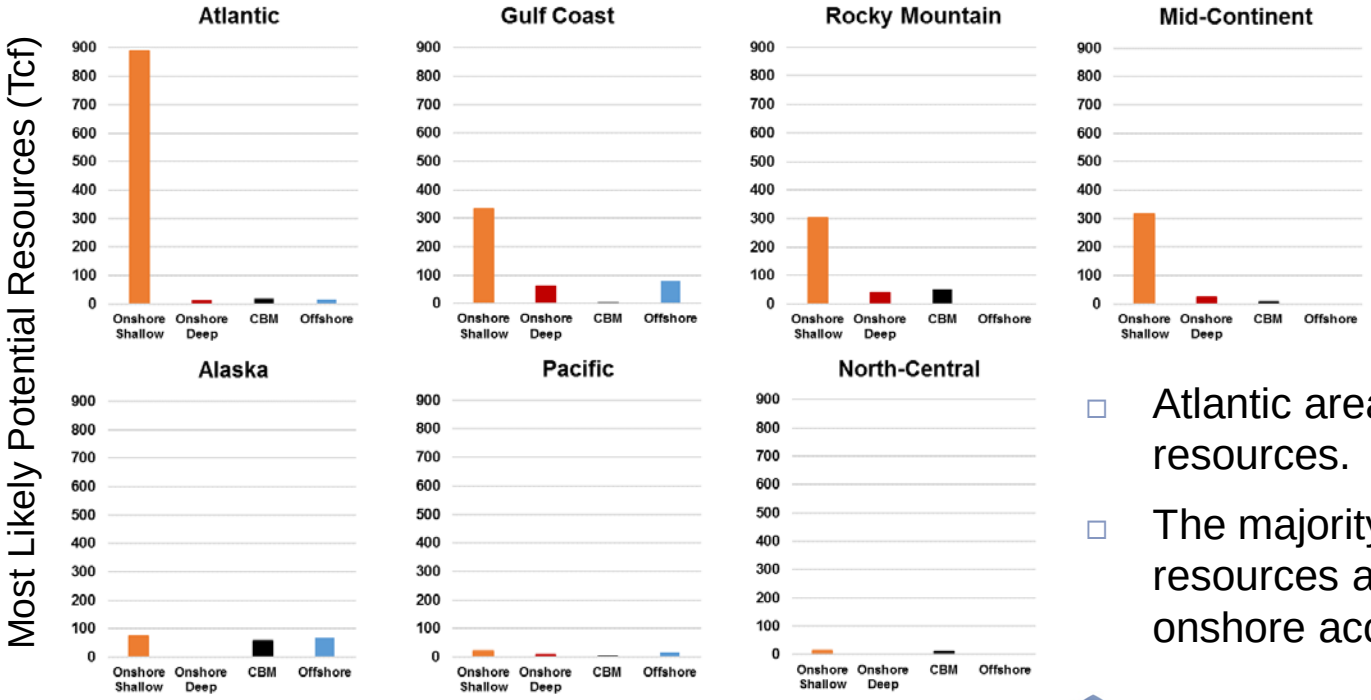
2016 gas resource assessment for Areas



Red values – Total Traditional resources (conventional, tight, shale reservoirs) (mean values, Tcf)

Black values – Coalbed gas resources (most likely values, Tcf)

Comparison of gas resources in Areas

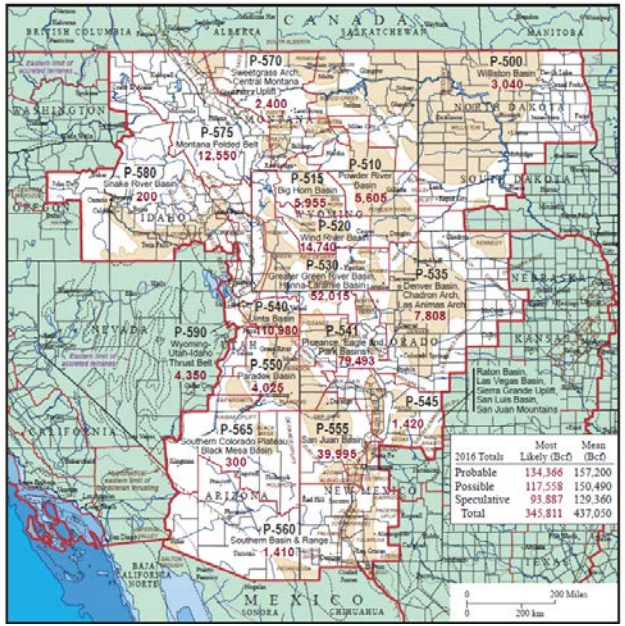


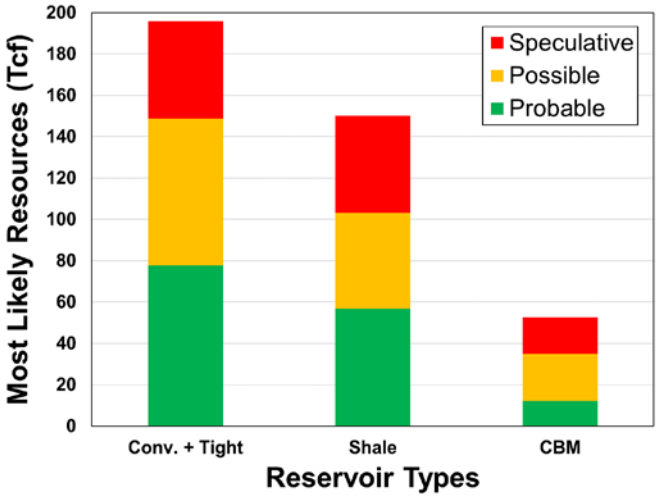
- Atlantic area has most gas resources.
- The majority of gas resources are in shallow onshore accumulations.

Areas ranked based on total gas resources (excluding coalbed gas)

PGC Assessment Area	Mean Technically Recoverable Volumes (trillion cubic feet or Tcf)	Proportion
Atlantic	1,047.5	39.4%
Gulf Coast	537.5	20.2%
Rocky Mountain	437.1	16.5%
Mid-Continent	369.6	13.9%
Alaska	193.8	7.3%
Pacific	53.9	2.0%
North Central	18.9	0.7%
Total U.S.	**2,658.3**	

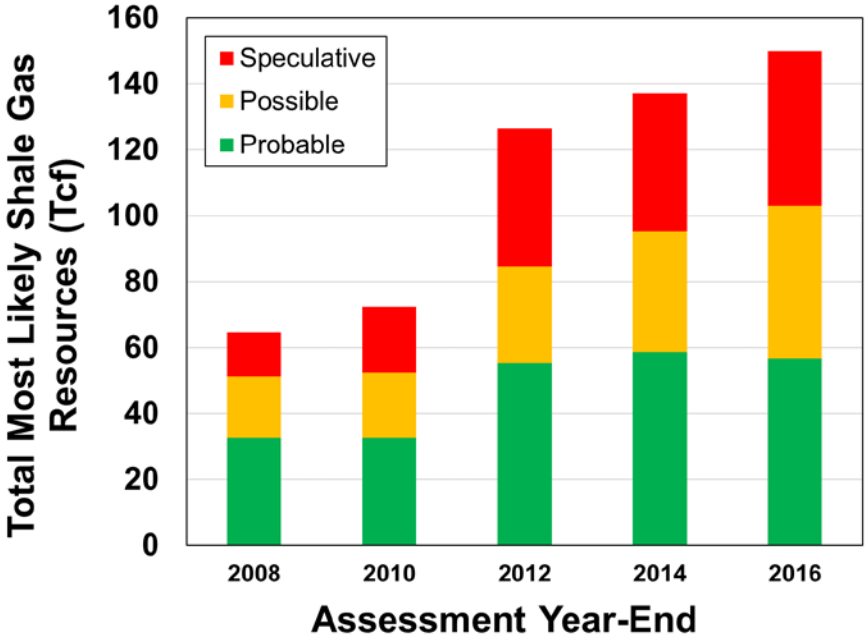
Rocky Mountain Area 2016 assessment





- Total Most Likely 398.4 Tcf.
- Conventional and tight reservoir still dominate.
- Around 49% of all gas resources are in two provinces:
  - The Uinta basin (P-540),
  - Piceance/Eagle/Park basins (P-541).

Rocky Mountain Area shale gas resources

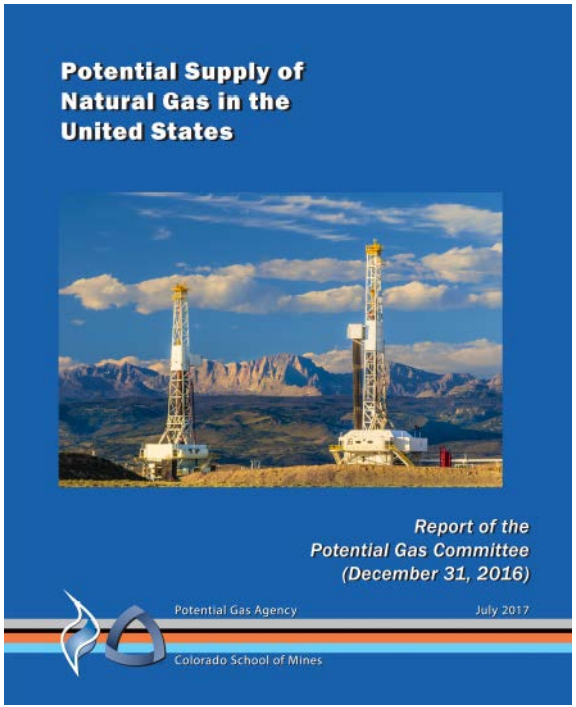


- PGC started to separately report shale gas resources in 2006.
- First report of shale gas for Rocky Mountain Area in 2008.
- Total Most Likely ~150 Tcf at year-end 2016.
- 38% of all gas resources.
- Dominated by Uinta and Piceance/Eagle/Park basins (Mancos/Niobrara).

Summary of year-end 2016 assessment

- 2,817 Tcf of total U.S. gas resources (mean value).
- 302 Tcf or 12% increase over the previous year-end 2014 assessment.
- Atlantic area has 39% of traditional U.S. gas resources.
- Shale gas accounts for 64% of total U.S. gas resources.
- Total U.S. future gas supply (reserves+resources) stands at record 3,141 Tcf. This is an increase of 288 Tcf or 10% over the previous year-end 2014 assessment.

Additional information and report request



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