SOURCE COMPANION

The Natural Gas Pipeline

Ketineni Ramarao

How to use this companion

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Reading status. **Read** means the page or document was fetched and the relevant passage read in context. **Passage verified** means the passage was compared with the sentence in the book and supports it, either in the owning source (the regulator, operator, court, agency or original estimator) or in a secondary or reference source whose figure originates upstream; each entry says which. Where two sources give different figures for the same thing, the book attributes each figure to its own source and does not merge them. Figures are quoted as the source states them.

Worked examples and diagrams were computed for this book from the formulas cited, and are labelled as illustrative.

Forecasts and plans are labelled as such in the book. Operator and government statements are attributed to their authors.

1. FERC - natural gas composition and pipeline quality
https://www.ferc.gov/sites/default/files/2020-04/G-1_29.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 1.
Supports: Principally methane with varying amounts of other hydrocarbons and contaminants.

2. Enbridge Gas - learn about natural gas
https://www.enbridgegas.com/about-enbridge-gas/learn-about-natural-gas

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 1.
Supports: Natural gas mainly methane.

3. Springer - energy density of natural gas versus crude oil
https://springerlink.fh-diploma.de/chapter/10.1007/978-3-030-86884-0_2

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 1.
Supports: Volumetric energy density almost 1,000 times lower than crude oil.

4. O'Reilly - The Natural Gas Revolution, chapter 3
https://www.oreilly.com/library/view/the-natural-gas/9780133353549/ch03.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 1.
Supports: One barrel of oil equals the energy of 5,659 cubic feet of gas.

5. Lash and Lash, Early History of the Natural Gas Industry, Fredonia, New York (AAPG Search and Discovery 90189)
https://www.searchanddiscovery.com/abstracts/html/2014/90189ace/abstracts/1837977.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 1, 3.
Supports: Upper Devonian black shale source; first commercial well on Canadaway Creek.

6. Sichuan provincial local-chronicle office - Li Bing and Sichuan well salt (in Chinese)
http://scdfz.sc.gov.cn/whzh/slzc1/content_22110

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 1.
Supports: Salt wells at Linqiong and Pujiang in 67 BCE; fire-well trough; bamboo tubes for brine.

7. npj Heritage Science - the craft of Tianche, timber salt-well structures of the Sichuan Basin
https://www.nature.com/articles/s40494-024-01290-6

Status: *Read*. Cited in chapter 1.
Supports: Tianche originate in the Han dynasty, reach up to 110 m.

8. Historylines - Chinese oil and gas wells, bamboo pipelines
https://www.historylines.net/history/chinese/oil_well2.html

Status: *Read*. Cited in chapter 1.
Supports: Describes bamboo pipes for gas in Sichuan salt works. A popular history site; treated as a secondary account.

9. Energy Institute - Statistical Review of World Energy 2025
https://www.energyinst.org/__data/assets/pdf_file/0007/1658077/Statistical-Review-of-World-Energy.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 1.
Supports: Production 4,124 bcm; top four producers 53 percent.

10. Industrial Info - Energy Institute: global gas use and production set records in 2024
https://www.industrialinfo.com/news/article/energy-institute-global-gas-use-and-production-set-records-in-2024--343506

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 1.
Supports: Consumption about 4,128 bcm, up 2.5 percent.

11. Global Energy Monitor - Global Gas Infrastructure Tracker
https://globalenergymonitor.org/projects/global-gas-infrastructure-tracker

Status: *Read*. Cited in chapter 1.
Supports: 4,158 pipelines tracked; 1.5 million km.

12. PHMSA - Annual Report Mileage for Natural Gas Transmission & Gathering Systems
https://www.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-natural-gas-transmission-gathering-systems

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 1, 12.
Supports: 2025 annual-report row: 300,217 miles total transmission; 113,143 miles total gathering (operators' reports to PHMSA).

13. PHMSA - Annual Report Mileage for Gas Distribution Systems
https://www.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-gas-distribution-systems

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 1, 12.
Supports: 2025 annual-report row: 1,394,662 miles of distribution mains.

14. National Gas Museum - The early days
https://www.nationalgasmuseum.org.uk/discover/the-early-days/

Status: *Read*. Cited in chapter 2.
Supports: Murdoch lit his Cornwall house with coal gas in 1792; Boulton and Watt built gasworks; cotton mill in Manchester in 1806.

15. Museum of London - How gas lamps illuminated London
https://www.londonmuseum.org.uk/collections/london-stories/gas-lamps-illuminated-london/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 2.
Supports: Gas lighting arrived in London in 1807; cheaper and brighter than oil lamps; explosion risk.

16. Tarr and Clay, manufactured gas in American cities (Pennsylvania Magazine of History and Biography)
https://journals.psu.edu/pmhb/article/download/62916/61919

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 2.
Supports: Manufactured gas from organic fuels developed in Europe and transferred to the United States.

17. Science History Institute - what does danger smell like
https://www.sciencehistory.org/stories/magazine/what-does-danger-smell-like/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 2, 11.
Supports: After several explosions following Los Angeles's 1927 switch to natural gas, providers began testing odorants (Calodorant); complaints of leaks soared and other cities followed.

18. Wales and West Utilities - lessons learnt on past gas transitions
https://www.wwutilities.co.uk/media/hrdlcu1u/lessons-learnt-from-the-past.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapters 2, 26.

Supports: Main conversion programme 1967 to 1977; 13 million customers and 40 million appliances.

19. National Gas Museum - the natural gas era
https://www.nationalgasmuseum.org.uk/discover/the-natural-gas-era/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 2.

Supports: Gas imported to Britain by ship in liquid form from 1959; large Yorkshire coast finds in 1965.

20. EIA Energy Kids - Natural gas timeline
https://www.eia.gov/kids/history-of-energy/timelines/natural-gas.php

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 3.

Supports: 1821 Fredonia attribution; 1891 Indiana-to-Chicago 120-mile line.

21. AAPG Explorer - Kicking down the well (Fredonia)
https://www.aapg.org/news-and-media/explorer/kicking-down-the-well/

Status: *Read*. Cited in chapter 3.

Supports: Documentary record of Hart's well in the Fredonia Censor of 1825; wooden pump-logs, lead and tin pipe; washtub gasometer.

22. Petroleum History Institute - the whale oil era
https://petroleumhistory.org/OilHistory/pages/Whale/whale.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 3.

Supports: Natural gas piped five miles to Titusville from the Newton well in 1872.

23. Wikipedia - Natural gas pipeline system in the United States
https://en.wikipedia.org/wiki/Natural_gas_pipeline_system_in_the_United_States

Status: *Read*. Cited in chapters 3, 5, 9, 12.

Supports: Pittsburgh 1883 wrought-iron line; telescoping coupling; compressors after 1910; 2025 PHMSA mileage; state mileage. Secondary source, used for orientation.

24. Pennsylvania Conservation Heritage - Westinghouse gas wells in Pittsburgh
https://paconservationheritage.org/stories/westinghouse-gas-wells-pittsburgh/

Status: *Read*. Cited in chapter 3.

Supports: 1883-84 gas venture at Solitude; stopcock; patent; Philadelphia Company; meter.

25. Magnolia Pipeline marker narrative
http://ka-electronics.com/images/pdf/Magnolia_Pipeline_Marker_Narrative.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapters 3, 5.
Supports: Early long-distance gas lines limited by leaks and the difficulty of making enough line pipe.

26. Salzgitter AG history - the Mannesmann seamless tube process
https://geschichte.salzgitter-ag.com/en/faq/what-is-the-mannesmann-seamless-tube-making-process

Status: *Read*. Cited in chapter 4.
Supports: Patent applied for 1885, granted 1886; pilger rolling developed in the early 1890s.

27. Octal Steel - API 5L X80
https://www.octalsteel.com/resources/api-5l-x80/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 4.
Supports: X80 PSL2 yield strength 555 to 705 MPa; low-carbon microalloyed design.

28. EUROPIPE - production and company
https://www.europipe.com/en/unternehmen/produktion

Status: *Read*. Cited in chapter 4.
Supports: Muelheim plant: up to 1.4 million tonnes, about 2,000 km of pipe a year; company founded 1991.

29. Niobium Tech - High-strength line pipe by Steckel mill rolling and spiral pipe forming
https://niobium.tech/-/media/niobiumtech/attachments-biblioteca-tecnica/nt_production-of-high-strength-line-pipe-steel-by-steckel-mill-rolling-and-spiral-pipe-forming.pdf

Status: *Read*. Cited in chapter 4.
Supports: Controlled rolling, spiral forming and double submerged arc welding of line pipe.

30. INGAA - girth weld failures in X70 pipelines joint industry project
https://ingaa.org/wp-content/uploads/2021/03/38629.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 4.
Supports: Failures at girth welds in X70 pipe welded under API 1104 procedures.

31. eCFR - 49 CFR 192.105, design formula for steel pipe
https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-D/part-192/subpart-C/section-192.105

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 4.
Supports: P = (2St/D) x F x E x T with S yield strength, t nominal wall, D outside diameter, F design factor (192.111), E longitudinal joint factor (192.113), T temperature derating factor (192.115).

32. eCFR - 49 CFR 192.111, design factor (F) for steel pipe
https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-D/part-192/subpart-C/section-192.111

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 4, 8.
Supports: Class 1: 0.72; Class 2: 0.60; Class 3: 0.50; Class 4: 0.40. Class 1 requires 0.60 or less at some road and rail crossings, on bridges and in fabricated assemblies, and 0.50 or less in compressor, regulating and measuring stations and offshore platforms.

33. Batalin, Urengoi-Pomary-Uzhgorod pipeline (OSTI/ETDE abstract, 1983)
https://www.osti.gov/etdeweb/biblio/5793338

Status: *Read*. Cited in chapters 4, 9, 14.
Supports: 2,765 miles; 2.7 million tonnes of pipe; 40 compressor stations over 3 million kW; 794 water crossings.

34. Encyclopedia.com - Transco Energy Company
https://www.encyclopedia.com/books/politics-and-business-magazines/transco-energy-company

Status: *Read*. Cited in chapters 4, 12.
Supports: Organised 1948; 1,832 miles, Hidalgo County to New York City; more than 540,000 tons of steel; 40 rivers.

35. Kinder Morgan - Today in company history: Natural Gas Pipeline Company
https://kindermorgan.com/Pages/Energy-Delivered/Today-in-Company-History-Natural-Gas-Pipeline-Company-Ushers-in-a-New-Era-c7d25226708108a2c3859c8b35adfb3e

Status: *Read*. Cited in chapters 5, 9, 12.
Supports: Texas-Chicago line completed 5 August 1931; 900-plus miles; 18 rivers; ten compressor stations; 24-inch.

36. Legal Clarity - API 1104
https://legalclarity.org/api-1104-welding-of-pipelines-and-related-facilities/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 5.
Supports: API 1104 first published in 1953.

37. TWI - What is stove pipe welding?
https://www.twi-global.com/technical-knowledge/faqs/faq-what-is-stove-pipe-welding

Status: *Read*. Cited in chapter 5.
Supports: Downhill manual welding of pipe girth joints, cellulosic electrodes, root, hot, filler and cap passes.

38. Pipeliner - automated pipeline welding systems, past, present and future
https://www.pipeliner.com.au/automated-pipeline-welding-systems-past-present-and-into-the-future/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 5.
Supports: Offshore installation from the 1960s drove demand for faster welding.

39. OSTI - automatic pipeline welding systems
https://www.osti.gov/biblio/6168493

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 5.
Supports: Five commercial automatic welding systems from CRC, H.C. Price, Diametrics and Arcos (Orbimatic).

40. NTSB - San Bruno investigation DCA10MP008
https://www.ntsb.gov/investigations/Pages/DCA10MP008.aspx

Status: *Read*. Cited in chapter 5.
Supports: 9 September 2010; 30-inch Line 132; 8 killed; 38 homes destroyed; probable cause.

41. NTSB - San Bruno, California investigation DCA10MP008 (what happened, findings)
https://www.ntsb.gov/investigations/Pages/DCA10MP008.aspx

Status: *Read*. Cited in chapters 5, 21.
Supports: Line 132 rupture 9 Sept 2010; 30-inch; 47.6 million scf; 38 homes destroyed, 70 damaged, 8 killed; probable cause, exemptions from pressure testing, no remote or automatic valves.

42. PHMSA - Phases of Pipeline Construction
https://www.phmsa.dot.gov/technical-resources/pipeline/pipeline-construction/phases-pipeline-construction-overview

Status: *Read*. Cited in chapters 5, 7.
Supports: Pipeline installation as an assembly-line sequence: survey and clearing, topsoil, stringing, bending, trenching, lowering in, backfill, hydrostatic testing.

43. PHMSA - Fact Sheet: Cathodic Protection
https://primis.phmsa.dot.gov/stakeholder-comms/factsheets/fscathodicprotection/

Status: *Read*. Cited in chapter 6.
Supports: Corrosion as an electrochemical reaction; sacrificial and impressed-current cathodic protection; coatings used with CP; gas pipe installed after 31 July 1971 must be coated and have CP.

44. PHMSA - Fact Sheet: Corrosion
https://primis.phmsa.dot.gov/stakeholder-comms/factsheets/fscorrosion/

Status: *Read*. Cited in chapter 6.
Supports: Corrosion is electrochemical oxidation; about 18 per cent of pipeline incidents 1998-2017 were caused by corrosion.

45. PHMSA - Fact Sheet: Pipe Coatings
https://primis.phmsa.dot.gov/stakeholder-comms/factsheets/fspipecoatings/

Status: *Read*. Cited in chapter 6.
Supports: Early tape and coal-tar coatings; disbonding; factory-applied coatings, fusion bonded epoxy most widely used; girth welds coated in the field.

46. ETH Zurich - the mystery of cathodic protection
https://ethz.ch/en/news-and-events/eth-news/news/2024/06/the-mystery-of-cathodic-corrosion-protection-clarified.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 6.
Supports: Humphry Davy described cathodic protection for Royal Navy hulls about two hundred years ago.

47. Corrosion Service - Would the real -850 mVCSE potential criterion please stand up

https://products.corrosionservice.com/ts1547036879/attachments/Page/46/1347%20Would%20the%20Real%20-850mVcse%20Potential%20Criterion%20Please%20Stand%20Up.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 6.

Supports: Kuhn, New Orleans pipelines, stated a potential criterion in a 1933 paper; the -850 mV CSE criterion has been debated.

48. Oil and Gas Journal - SCC review

https://www.ogj.com/general-interest/hse/article/17236189/ops-review-addresses-scc-threat-to-pipeline-integrity

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 6.

Supports: First known case of SCC identified after a 1965 rupture near Natchitoches, Louisiana.

49. PHMSA technical resource - stress corrosion cracking

https://primis.phmsa.dot.gov/stakeholder-comms/factsheets/fsstresscorrosion/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 6.

Supports: Both forms of SCC occur as colonies of parallel cracks perpendicular to the highest stress.

50. NTSB - Carlsbad investigation DCA00MP009

https://www.ntsb.gov/investigations/Pages/DCA00MP009.aspx

Status: *Read*. Cited in chapter 6.

Supports: 19 August 2000; 30-inch line; twelve killed; internal corrosion.

51. EHS Today - NTSB: fatal NM pipeline rupture

https://www.ehstoday.com/archive/article/21907202/ntsb-fatal-nm-pipeline-rupture-caused-by-corrosion

Status: *Read*. Cited in chapter 6.

Supports: Internal corrosion reduced wall thickness; microbes among likely causes.

52. INGAA - Building Interstate Natural Gas Transmission Pipelines: A Primer (2013)
https://ingaa.org/wp-content/uploads/2023/09/2013_Building-Interstate-Natural-Gas-Transmission-Pipelines-A-Primer.pdf

Status: *Read*. Cited in chapter 7.
Supports: Long-haul projects built in sections called construction spreads, working like a moving assembly line.

53. Oil and Gas Journal - land pipeline construction costs
https://www.ogj.com/pipelines-transportation/pipelines/article/14299952/land-pipeline-construction-costs-rise-in-2023

Status: *Read*. Cited in chapter 7.
Supports: Higher miscellaneous costs raised land pipeline cost by more than $2 million per mile.

54. Global Energy Monitor - global gas pipeline expansion
https://globalenergymonitor.org/research/global-gas-pipeline-expansion-nearly-us200-billion-under-construction-asia-building-over

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 7.
Supports: About 69,700 km under construction at US$193.9 billion; Asia 82 percent.

55. U.S. Fish and Wildlife Service - NiSource HCP Appendix J, Horizontal Directional Drilling
https://www.fws.gov/sites/default/files/documents/NiSourceHCPfinalAppndxJ_HDD.pdf

Status: *Read*. Cited in chapter 7.
Supports: Pilot hole, steerable drill string, downhole survey, prereaming passes and pipe pullback.

56. Trenchless Technology - Martin Cherrington
https://trenchlesstechnology.com/trenchless-pioneers-martin-cherrington/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 7.
Supports: 1971 river crossing for PG&E started horizontal directional drilling.

57. Wartsila Encyclopedia - Pipelaying methods
https://www.wartsila.com/encyclopedia/term/pipelaying-methods

Status: *Read*. Cited in chapter 7.
Supports: S-lay with stinger and tensioners, J-lay for deep water, reel-lay.

58. Saipem - Offshore pipelines
https://www.saipem.com/sites/default/files/2022-11/Offshore%20pipelines.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 7.
Supports: Late-1970s Transmed in 600 m water depths; world record at the time.

59. Oil and Gas Journal via OSTI - Strait of Sicily lines (1979)
https://www.osti.gov/biblio/6718747

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 7.
Supports: $237 million Saipem contract for three 20-inch lines from Cap Bon to Mazara del Vallo.

60. Wikipedia - Langeled pipeline
https://en.wikipedia.org/wiki/Langeled_pipeline

Status: *Read*. Cited in chapters 7, 8.
Supports: 1,166 km; 25.5 bcm a year; 42-44 inch; Ormen Lange to Easington.

61. Gazprom - TurkStream
https://www.gazprom.com/projects/turk-stream/

Status: *Read*. Cited in chapter 7.
Supports: 31.5 bcm design capacity; more than 930 km offshore per string; supplies began January 2020.

62. TurkStream fact sheet
https://turkstream.info/project/technology/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 7.
Supports: Two lines, 81 cm pipe, depths exceeding 2 km (2,200 m maximum).

63. Anadolu Agency - Pioneering Spirit completes TurkStream
https://www.aa.com.tr/en/economy/turkstreams-giant-pipelaying-vessel-pioneering-spirit/1317436

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 7.
Supports: 1,860 km of pipe laid in the Black Sea for two lines.

64. Allseas - Solitaire
https://www.allseas.com/en/who-we-are/our-fleet/solitaire

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 7.
Supports: Launched 1998; record-setting pipelay vessel.

65. Nord Stream AG - second pipeline press release
https://www.nord-stream.com/press-info/press-releases/nord-streams-second-pipeline-sections-to-be-joined-together-underwater-412/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 7, 8.

Supports: Design pressure drops from 220 to 177.5 bar across three sections of reducing wall thickness.

66. Gazprom - Nord Stream
https://www.gazprom.com/projects/nord-stream/

Status: *Read*. Cited in chapters 7, 8.

Supports: 1,224 km; 55 bcm; Portovaya compressor station 366 MW; 1,220 mm pipe; 220 bar outlet; Gazprom's claim of no intermediate compressors.

67. CED Engineering - Gas Pipeline Hydraulics
https://www.cedengineering.com/userfiles/Gas%20Pipeline%20Hydraulics%20R1.pdf

Status: *Read*. Cited in chapter 8.

Supports: Gas compressibility; gas velocity varies along a pipeline; Weymouth and Panhandle equations in industry use.

68. Midstream Calculator - gas compressibility factor fundamentals
https://midstreamcalculator.com/engineering/thermodynamics/z-factor-fundamentals.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 8.

Supports: Z is the ratio of actual molar volume to ideal-gas volume at the same pressure and temperature.

69. Weymouth, T. R., Problems in Natural Gas Engineering, Transactions of the ASME, vol. 34 (1912), pp. 185-231
https://doi.org/10.1115/1.4059982

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 8.

Supports: The 1912 ASME paper in which Weymouth set out his gas flow formula (publication record: title, author, year, journal, pages).

70. LANL GasModels - Weymouth steady-state model
https://lanl-ansi.github.io/GasModels.jl/latest/math-model/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 8.

Supports: Steady-state Weymouth formulation of 1-D gas flow.

71. Penn State PNG 520 - gas pipeline flow equations
https://courses.ems.psu.edu/png520/print/m21_p2.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 8.

Supports: Design equations relate pressure drop to flow rate.

72. INGAA - Interstate Pipeline Desk Reference (2009), Pipeline Network
https://ingaa.org/wp-content/uploads/2008/01/6070.pdf

Status: *Read*. Cited in chapter 9.

Supports: Three prime movers: turbine with centrifugal compressor, reciprocating engine with reciprocating compressor, electric motor.

73. Turbomachinery Magazine - gas turbine market report 2024
https://www.turbomachinerymag.com/view/gas-turbine-market-report-2024-posts-highest-units-mws-in-22-years

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 9.

Supports: GE Vernova and Baker Hughes together about 85 percent of the aeroderivative gas turbine market.

74. Journal of Petroleum Technology - optimisation of fuel consumption of compressor stations
https://jpt.spe.org/optimization-fuel-consumption-compressor-stations

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 9.

Supports: Compressor stations often consume 3 to 5 percent of the gas they transport.

75. UPI - Caterpillar sale blocked (29 December 1981)
https://www.upi.com/Archives/1981/12/29/Caterpillar-sale-blocked/3552378450000/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapters 9, 14.

Supports: Permit for 200 pipelayers worth $80 million rescinded.

76. Penn State Extension - Understanding Natural Gas Compressor Stations
https://extension.psu.edu/understanding-natural-gas-compressor-stations

Status: *Read*. Cited in chapter 9.

Supports: Scrubbers and filters at station entry; compression heat removed by an aerial after-cooler; piston-engine or gas-turbine drivers.

77. National Gas - what is linepack
https://www.nationalgas.com/our-businesses/nts-linepack

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 10.

Supports: Linepack is the total volume of gas contained within the system.

78. CEDIGAZ - Underground gas storage in the world, 2025 edition (contents and summary)
https://www.cedigaz.org/wp-content/uploads/UGS-2025-contents.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 10.

Supports: Storage categories tracked: depleted gas fields, aquifers, salt caverns, oil fields, rock caverns; record world capacity at end of 2024.

79. US Department of Energy - U.S. Natural Gas Storage Capacity and Utilization Outlook (2017)
https://www.energy.gov/sites/prod/files/2017/01/f34/U.S.%20Natural%20Gas%20Storage%20Capacity%20and%20Utilization%20Outlook_0.pdf

Status: *Read*. Cited in chapter 10.

Supports: Storage modulates seasonal demand: a demand sink in summer and a supply source in winter.

80. Science - Conley et al., methane emissions from the 2015 Aliso Canyon blowout
https://www.science.org/doi/10.1126/science.aaf2348

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 10, 22.

Supports: Blowout late October 2015 to February 2016; up to 60 t methane per hour; 97,100 t total.

81. California Air Resources Board - Aliso Canyon natural gas leak
http://ww2.arb.ca.gov/our-work/programs/aliso-canyon-natural-gas-leak

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 10.

Supports: Mitigation of 109,000 metric tons of methane-equivalent.

82. FERC - Final report on February 2021 freeze underscores winterization recommendations (16 November 2021)
https://www.ferc.gov/news-events/news/final-report-february-2021-freeze-underscores-winterization-recommendations

Status: *Read*. Cited in chapters 10, 24.

Supports: Uri caused numerous outages, derates or failures to start at generating plants; ERCOT ordered 20,000 MW of rolling blackouts; natural gas fuel supply issues caused by production declines, 43.3 percent of them from freezing.

83. Emerson - ultrasonic flow meters in custody transfer
https://www.emerson.com/is/content/emerson/en/measurement-instrumentation/marketing/products/flow-ultrasonic/documents/doc-rosemount-00870-0200-4646.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 11.

Supports: Multipath ultrasonic meters used in custody transfer for more than 35 years.

84. TSHA - New London school explosion
https://www.tshaonline.org/handbook/entries/new-london-school-explosion

Status: *Read*. Cited in chapter 11.

Supports: 18 March 1937; about 298 died; school tapped a residue gas line; state odorisation law.

85. Railroad Commission of Texas - history
https://www.rrc.texas.gov/about-us/rrc-history/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 11.

Supports: After the 1937 New London school explosion the 45th Legislature (House Bill 1017) gave the Commission authority to adopt rules on the odorization of natural gas or LP gases.

86. PHMSA - Fact Sheet: In-Line Inspections (Smart Pig)
https://primis.phmsa.dot.gov/stakeholder-comms/factsheets/fssmartpig/

Status: *Read*. Cited in chapter 11.

Supports: Pigs clean; smart pigs measure corrosion, cracks and dents; magnetic flux leakage and ultrasonic tools; transverse flux tools for axial defects.

87. Pipeliner - the origin of intelligent pigs
https://www.pipeliner.com.au/internationalnews/the-origin-of-intelligent-pigs/

Status: *Read*. Cited in chapter 11.

Supports: 1959 caliper tool and the MFL development; Shell remote-field tool.

88. AUCSC - Today's ILI (2018)
https://aucsc.com/downloads/TT_Today's%20ILI_2018.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 11.

Supports: Tuboscope tool of 1964 had six sensors and inspected the bottom quarter of the pipe.

89. Inspectioneering - history of in-line inspection tools
https://inspectioneering.com/journal/2017-04-27/6416/a-history-of-in-line-inspection-tools

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 11.

Supports: First commercial smart pig built in 1964 with magnetic flux leakage; high-resolution tools in the 1970s.

90. PHMSA - Control Room Management
https://www.phmsa.dot.gov/pipeline/control-room-management/control-room-management

Status: *Read*. Cited in chapter 11.

Supports: Regulations cover controllers, control rooms and SCADA systems used to monitor and control pipelines remotely.

91. Texas State Historical Association - Big Inch and Little Big Inch
https://www.tshaonline.org/handbook/entries/big-inch-and-little-big-inch

Status: *Read*. Cited in chapter 12.

Supports: Construction dates, cost $146 million, postwar sale to Texas Eastern for $143,127,000 on 14 November 1947.

92. Enbridge - Texas Eastern purchases the war pipelines
https://www.enbridge.com/viewer?item=27F6E2EE5E1B466D899B8C20313183E8

Status: *Read*. Cited in chapter 12.

Supports: Texas Eastern formed 1947 to buy the lines, later converted to natural gas.

93. Williams newsletter - Transco Connection, Fall 2009
https://www.1line.williams.com/Files/Transco/Newsletters/Fall09_TranscoConnection.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 12.

Supports: Company newsletter (Fall 2009): Claude Williams, founding president, earlier gathered investors to bid for the war emergency pipelines (Big and Little Inch); the bid failed; 1,832-mile line; more than 540,000 tons of steel; groundbreaking 23 May 1949.

94. Williams - Transco at 75
https://www.williams.com/2025/12/04/transco-at-75-the-backbone-of-americas-energy-future/

Status: *Read*. Cited in chapters 12, 23.
Supports: In service 1950; about 16 percent of US gas consumed; network nearly 10,000 miles.

95. US Energy Information Administration - Annual U.S. natural gas production decreased by 1% in 2020
https://www.eia.gov/todayinenergy/detail.php?id=46956

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 12.
Supports: Appalachia remains the largest natural gas producing region in the United States; Marcellus and Utica/Point Pleasant shales of Ohio, West Virginia and Pennsylvania.

96. US EIA - Natural Gas Weekly Update, 3 September 2015
https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2015/09_03/index.php

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 12, 26.
Supports: Rockies Express incrementally increased westward capacity on the line to 1.8 Bcf/d.

97. The Canadian Encyclopedia - TransCanada PipeLines Limited
https://thecanadianencyclopedia.ca/en/article/transcanada-pipelines-limited

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 13.
Supports: Incorporated 21 March 1951 as Trans-Canada Pipe Lines; subsidiary of Canadian Delhi.

98. The Canadian Encyclopedia - Pipeline Debate, 1956
https://thecanadianencyclopedia.ca/en/article/pipeline-debate

Status: *Read*. Cited in chapter 13.
Supports: Debate dates 8 May-6 June 1956; C. D. Howe.

99. Wikipedia - TransCanada pipeline
https://en.wikipedia.org/wiki/TransCanada_pipeline

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 13.
Supports: 3,500 km laid in 1956-1958 from Alberta-Saskatchewan border to Toronto and Montreal; 50-50 financing.

100. Alberta's Energy Heritage - TransCanada Pipeline
https://history.alberta.ca/EnergyHeritage/gas/transformation/pipelines/transcanada-pipeline.aspx

Status: *Read*. Cited in chapter 13.
Supports: Longer than any other single pipeline in North America at the time.

101. Northern Pipeline Agency - Alaska Highway gas pipeline
https://northern-pipeline.canada.ca/about-the-agency/the-alaska-highway-gas-pipeline-project/pipeline-history

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 13.
Supports: 214 days of National Energy Board hearings 1975-77; 1977 transit pipelines treaty.

102. LNGnews.ru - The first pipe is the hardest (in Russian)
https://lngnews.ru/2020/11/10701/pervaya-truba-samaya-trudnaya/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 14.
Supports: Elshanka gas found 1941, 16 km from Saratov; line built in about six weeks to the power station; Saratov-Moscow line called the first long-distance gas pipeline in the USSR.

103. Russian Wikipedia - Saratov-Moscow gas pipeline (in Russian)
https://ru.wikipedia.org/wiki/%D0%93%D0%B0%D0%B7%D0%BE%D0%BF%D1%80%D0%BE%D0%B2%D0%BE%D0%B4_%D0%A1%D0%B0%D1%80%D0%B0%D1%82%D0%BE%D0%B2_%E2%80%94_%D0%9C%D0%BE%D1%81%D0%BA%D0%B2%D0%B0

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 14.
Supports: 843 km; six compressor stations; 325 mm; 5.5 MPa; in service 11 July 1946.

104. Gas Transmission System Operator of Ukraine - history
https://tsoua.com/en/about-us/history/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.
Supports: Brotherhood pipeline commissioned 1967.

105. Naftogaz - remarkable historical highlights
https://www.naftogaz.com/en/remarkable-historical-highlights

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.
Supports: 1967 export to Czechoslovakia; 1978 Soyuz, first transcontinental gas pipeline.

106. OMV - 50 years of reliable supplies
https://www.omv.com/en/media/press-releases/2018/50-years-of-reliable-supplies-of-russian-gas-to-austria

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.
Supports: Soviet-Austrian gas supply agreement signed 1 June 1968.

107. Gazprom - Yamal-Europe
https://www.gazprom.com/projects/yamal-europe/

Status: *Read*. Cited in chapter 14.
Supports: Four countries: Russia, Belarus, Poland, Germany; 33 bcm a year.

108. Gas Transmission System Operator of Ukraine - operating without Russian transit (1 January 2025)
https://tsoua.com/en/news/the-ukrainian-gts-has-been-operating-without-russian-gas-transit-starting-from-january-1-2025/

Status: *Read*. Cited in chapter 14.
Supports: Transit ended at 7 a.m. Kyiv time on 1 January 2025.

109. The Guardian - Breakaway Moldovan region cuts heating as Russia stops gas flow (1 January 2025)
https://www.theguardian.com/world/2025/jan/01/breakaway-moldovan-region-cuts-heating-and-hot-water-as-russia-stops-gas-flow

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 14.
Supports: The only Russian gas route to Europe still in operation is TurkStream, to Hungary and Serbia.

110. TASS - Russian pipeline gas supplies to Europe rise by 14% in 2024
https://tass.com/economy/1895895

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.
Supports: TASS estimate based on Gazprom and ENTSOG data: 32.1 bcm in 2024, up 14 per cent from about 28.15 bcm in 2023; 15.4 bcm via Ukraine and 16.7 bcm via TurkStream.

111. Bruegel - Europe urgently needs a common strategy on Russian gas
https://www.bruegel.org/analysis/europe-urgently-needs-common-strategy-russian-gas

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapters 14, 15.

Supports: In 2021 Russia supplied 157 bcm, about half of EU gas imports.

112. European Commission communication COM(2025) 440
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52025DC0440

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.

Supports: In 2024 the EU imported 52 bcm of Russian gas (32 pipeline, 20 LNG), about 19 percent of imports.

113. Gazprom sustainability report 2024
https://sustainability.gazpromreport.ru/fileadmin/f/2024/gazprom-sustainability-report-2024-en.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 14.

Supports: Record 395.8 bcm delivered to the domestic market in 2024.

114. LNG Atlas - biggest gas pipeline owners by length
https://lngatlas.org/rankings/pipeline-owners/

Status: *Read*. Cited in chapter 14.

Supports: Gazprom 145,071 km; Kinder Morgan 63,020 km; ranking is a floor, built from GEM data.

115. Wikipedia - Groningen gas field
https://en.wikipedia.org/wiki/Groningen_gas_field

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.

Supports: Discovery 1959; production from 1963; peak year 1976.

116. Carnegie Endowment - gas pricing in Europe
https://carnegieendowment.org/files/gas_pricing_europe.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.

Supports: Groningen contracts' daily and annual flexibility; later export contracts could not replicate it.

117. University of Groningen law journal - Huizinge earthquake of 16 August 2012 (in Dutch)
https://pure.rug.nl/ws/portalfiles/portal/247733358/g_SDU_JBPL032022_559781.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.

Supports: The Huizinge quake of 16 August 2012 put Groningen damage on the political agenda.

118. Dutch government - Groningen gas extraction stops 1 October 2023
https://www.rijksoverheid.nl/actueel/nieuws/2023/06/23/gaswinning-groningen-stopt-per-1-oktober-2023

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.

Supports: Extraction at Groningen ended on 1 October 2023 after 60 years.

119. OSTI - Trans-Mediterranean pipeline under construction
https://www.osti.gov/biblio/5356723

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.

Supports: First intercontinental gas pipeline system; about 2,500 km.

120. Offshore Technology - Trans-Mediterranean pipeline
https://www.offshore-technology.com/projects/trans-med-pipeline/

Status: *Read*. Cited in chapter 15.

Supports: Built 1983; 30.2 bcm a year capacity; route Algeria, Tunisia, Sicily.

121. Fluxys - Interconnector UK infrastructure
https://www.fluxys.com/en/about-us/interconnector-uk/infrastructure

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.

Supports: Bacton to Zeebrugge; operations began October 1998.

122. Medgaz - FAQ and project presentation
https://www.medgaz.com/en/more-information/faqs/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 15, 17.

Supports: Beni Saf (Algeria) to Almeria (Spain); capacity 10.16 bcm a year after a fourth compressor at Beni Saf came into operation on 1 July 2022.

123. European Commission - Launch of the Baltic Pipe (27 September 2022)
https://commission.europa.eu/news/launch-baltic-pipe-2022-09-27_en

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.
Supports: Inaugurated in Goleniow, Poland on 27 September 2022 (the launch notice); the full-operation date is carried by the CINEA entry.

124. CINEA (European Commission) - The Baltic Pipe: a subsea pipeline to transport natural gas under the North Sea
https://cinea.ec.europa.eu/featured-projects/baltic-pipe-subsea-pipeline-transport-natural-gas-under-north-sea_en

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.
Supports: Baltic Pipe inaugurated in September 2022 at a ceremony in Poland; fully operational in November 2022.

125. Trans Adriatic Pipeline - commercial operations begin
https://www.tap-ag.com/news/news-stories/tap-starts-commercial-operations

Status: *Read*. Cited in chapter 15.
Supports: 878 km through Greece, Albania, the Adriatic and Italy; commercial operations 15 November 2020.

126. Equinor - Gas from Langeled reaches the British market (1 October 2006)
https://www.equinor.com/news/archive/2006/10/01/GasFromLangeledReachesTheBritishMarket

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 15, 19.
Supports: Norwegian gas exports to Britain via Langeled began 1 October 2006; official opening 16 October; Hydro was already selling gas via Langeled on the British exchange, the National Balancing Point (NBP).

127. Global Energy Monitor - Langeled Gas Pipeline
https://www.gem.wiki/Langeled_Gas_Pipeline

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.
Supports: Nyhamna to Easington; 1,164 km; 42-44 inch; capacity 25.5 bcm a year; operator Gassco.

128. Offshore Magazine - Single-run in-line pipeline inspection on an unprecedented scale
https://www.offshore-mag.com/equipment-engineering/article/16763859/single-run-in-line-pipeline-inspection-on-an-unprecedented-scale

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.
Supports: Langeled described as the world's longest subsea gas pipeline, 1,173 km, inspected in a single in-line run.

129. Gazprom - Nord Stream
https://www.gazprom.com/projects/nord-stream/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.
Supports: Two strings, 55 bcm a year, 1,224 km; construction launched April 2010; first string November 2011, second October 2012.

130. Reuters - Profile of the Nord Stream 1 gas link (10 July 2022)
https://www.reuters.com/business/energy/profile-nord-stream-1-gas-link-it-shuts-annual-maintenance-2022-07-10/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.
Supports: 1,224 km twin pipeline, 55 bcm combined capacity, cost 7.4 billion euros; operations from November 2011.

131. Deutsche Welle - US sanctions on Nord Stream 2
https://www.dw.com/en/us-announces-sanctions-on-nord-stream-2/a-60891522

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.
Supports: Nord Stream 2 cost about 9.5 billion euros.

132. Reuters - Germany halts Nord Stream 2 certification (22 February 2022)
https://www.reuters.com/business/energy/germanys-scholz-halts-nord-stream-2-certification-2022-02-22/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 15.
Supports: Certification halted after Russia recognised two regions in eastern Ukraine.

133. GEUS - Seismic analysis of the Nord Stream underwater explosions
https://pub.geus.dk/en/publications/seismic-analysis-of-the-nord-stream-underwater-explosions/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.

Supports: On 26 September 2022 northern European seismic networks detected two events near Bornholm; pressure drops reported on three of four strings of Nord Stream 1 and 2; four sea-surface gas leaks reported by Swedish and Danish authorities.

134. European Parliament question - Maghreb-Europe gas pipeline
https://www.europarl.europa.eu/doceo/document/E-9-2021-004956_EN.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 15, 17.

Supports: 1,400 km; since 1996; more than 10 bcm a year via Morocco; Algeria ordered an end on 31 October 2021.

135. Council of the EU - Council adopts regulation on gas storage (27 June 2022)
https://www.consilium.europa.eu/en/press/press-releases/2022/06/27/council-adopts-regulation-gas-storage/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 15.

Supports: Storage filled to at least 80 percent before winter 2022/23 and 90 percent before following winters.

136. China National Energy Administration - West-East Gas Pipeline 1 (in Chinese)
http://www.nea.gov.cn/2012-10/12/c_131902354.htm

Status: *Read*. Cited in chapter 16.

Supports: 3,843 km; construction began 4 July 2002; full line connected 1 October 2004; 12 bcm a year then 17 bcm by end of 2007.

137. China Daily (Xinhua) - Gas surges through world's longest pipeline (30 December 2012)
http://www.chinadaily.com.cn/china/2012-12/30/content_16069673.htm

Status: *Read*. Cited in chapter 16.

Supports: Second West-East line fully operational 30 December 2012: 8,704 km, one trunk and eight regional lines, Horgos (Xinjiang) to Hong Kong, 142.2 billion yuan, 15 provincial regions, 30 bcm a year.

138. National Energy Administration (People's Daily) - China forms a gas network of nearly 40,000 km (31 December 2012, in Chinese)
https://www.nea.gov.cn/2012-12/31/c_132073587.htm

Status: *Read*. Cited in chapter 16.
Supports: Second West-East line: 87 stations and 321 valve chambers, 192 county-level units; 20 built and under-construction pipelines connected; network of nearly 40,000 km at the end of 2012. Figures matched in Chinese text.

139. CAREC - Turkmenistan-China gas pipeline presentation
https://www.carecprogram.org/uploads/2014-Energy-Trade-Pres-Session7-3.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.
Supports: Line A opened December 2009, 15 bcm; Line B October 2010, 15 bcm; 1,830 km.

140. Hydrocarbon Processing - CNPC starts up new Myanmar-China gas pipeline (July 2013)
https://www.hydrocarbonprocessing.com/news/2013/07/cnpc-starts-up-new-myanmar-china-gas-pipeline/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.
Supports: 793 km, four Chinese provinces, up to 12 bcm a year to Yunnan (CNPC newsletter, 2013).

141. Euronews - Russia opens Power of Siberia gas pipeline to China (3 December 2019)
https://www.euronews.com/2019/12/03/russia-opens-power-of-siberia-gas-pipeline-to-china

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.
Supports: 3,000 km pipeline launched; project expected to last three decades.

142. Gazprom - Power of Siberia
https://www.gazprom.com/projects/power-of-siberia/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.
Supports: 38 bcm a year export capacity; Chayandinskoye and Kovyktinskoye fields.

143. Reuters - Russia, China bless vast new Power of Siberia 2 pipeline (September 2025)

https://www.reuters.com/business/energy/russia-china-bless-vast-new-power-siberia-2-pipeline-gazprom-says-2025-09-02/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.

Supports: Memorandum on Power of Siberia 2 through Mongolia; price and timeframe unclear.

144. People's Daily Overseas Edition - national long-distance gas pipelines total 124,000 km (24 July 2024, in Chinese)

http://paper.people.com.cn/rmrbhwb/html/2024-07/24/content_26070756.htm

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.

Supports: Report of China Natural Gas Development Report 2024: long-distance gas pipelines 124,000 km in 2023, up more than 4,000 km.

145. PipeChina news / CCTV - China-Russia East Route fully connected (9 December 2024, in Chinese)

https://www.pipechina.com.cn/front/news/3002125.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.

Supports: China-Russia East Route gas pipeline, 5,111 km, Heihe to Shanghai through 9 provinces, fully connected after nearly 10 years of construction.

146. Institute for Energy Research - China converts coal into oil, gas and chemicals

https://www.instituteforenergyresearch.org/fossil-fuels/china-converts-coal-into-oil-gas-and-chemicals/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.

Supports: 2024: China imported 43 percent of its gas supply (182.2 bcm); over half (105.6 bcm) LNG.

147. Reuters - China sets up national oil and gas pipeline firm (December 2019)

https://www.reuters.com/article/us-china-energy-pipeline-reform/china-sets-up-national-oil-and-gas-pipeline-company-idUSKBN1YD06T/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.

Supports: National pipeline company created to open access to infrastructure mainly controlled by the big state firms.

148. Columbia CGEP - Reform pipelines: PipeChina
https://www.energypolicy.columbia.edu/publications/reform-pipelines-pipechina-and-restructuring-china-s-natural-gas-market/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.
Supports: PipeChina assembled from midstream assets including pipelines, LNG terminals and storage.

149. National Development and Reform Commission - first regional pricing of inter-provincial gas pipeline transport (5 December 2023, in Chinese)
https://www.ndrc.gov.cn/xxgk/jd/jd/202312/t20231205_1362438.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.
Supports: First regional approval of tariffs for PipeChina inter-provincial gas pipelines: four zones (Northwest, Northeast, Central-East, Southwest); tariff rates cut from 20 to 4; price computed from the zone rate and the distance between entry and exit and published.

150. Mysteel (GL Consulting) - China to cut gas pipeline transmission tariffs from Jan 1, 2024
https://www.mysteel.net/news/5046321-china-to-cut-gas-pipeline-transmission-tariffs-from-jan-1-2024

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.
Supports: New regional tariffs effective 1 January 2024; most charges fall by 0.002 to 0.277 yuan per thousand cubic metres per km; Southwest tariff highest; new pipelines follow the zone benchmark; third-party access with transmission separated from sales.

151. PipeChina - business areas (in Chinese)
https://www.pipechina.com.cn/business.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 16.
Supports: Gas pipelines about 63,800 km at end of 2025; primary transport capacity about 420 bcm a year; links 25 domestic sources and Central Asia, Russia, Myanmar import lines, 25 LNG terminals, 21 storage facilities.

152. Wildlife Institute of India case study - HBJ pipeline
https://v1.wii.gov.in/eia/casestudies/pipeline_projects1_introduction2

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.
Supports: 1,850 km line installed 1986-89.

153. Wikipedia - Iran-Pakistan gas pipeline
https://en.wikipedia.org/wiki/Iran%E2%80%93Pakistan_gas_pipeline

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.

Supports: 2,775 km planned; construction began 2011.

154. Xinhua - 14 km of gas pipeline installed in Afghanistan as TAPI continues (13 October 2025)
https://english.news.cn/20251013/da5729e9bb784434b727439e48ce4850/c.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 16.

Supports: TAPI progress in Herat province.

155. TBG - technical information on the Bolivia-Brazil pipeline (in Portuguese)
https://www.tbg.com.br/informa%C3%A7%C3%B5es-t%C3%A9cnicas-do-gasoduto

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 17.

Supports: 3,150 km; operation from July 1999.

156. OSTI - The gas pipeline Bolivia-Brazil and the natural gas market expansion in Sao Paulo State
https://www.osti.gov/etdeweb/servlets/purl/20167928

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 17.

Supports: Letter of intent November 1991; sales and purchase contract February 1993 effective upon financing.

157. Petrobras Bolivia - company profile
https://petrobras.com.br/bolivia

Status: *Read*. Cited in chapter 17.

Supports: Gas sales contract signed August 1996 with YPFB; Gasbol construction began 1997, operation 1999.

158. Oil & Gas Journal - Gasbol pipeline contract talks focus on pre-salt, regional integration
https://www.ogj.com/pipelines-transportation/pipelines/article/17232247/gasbol-pipeline-contract-talks-focus-on-pre-salt-regional-integration

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 17.

Supports: Renewal of the 20-year contract complicated by pre-salt volume uncertainty and Bolivian reserves.

159. WAPCo - The West African Gas Pipeline
https://www.wagpco.com/wagp/

Status: *Read*. Cited in chapter 17.

Supports: 678 km; Itoki, Nigeria to Takoradi, Ghana; main line 20 inch; average depth 35 m; laterals to Cotonou, Lome, Tema; 85 percent of gas for power.

160. World Bank Inspection Panel - WAGP progress report
https://www.inspectionpanel.org/sites/www.inspectionpanel.org/files/ip/PanelCases/40-Third%20Management%20Progress%20Report.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 17.

Supports: Inspection Panel investigation report 25 April 2008 and management action plan.

161. NaturalGas.org - history of natural gas regulation
https://naturalgas.org/regulation/history/

Status: *Read*. Cited in chapter 18.

Supports: Natural Gas Act of 1938.

162. Pipeline Safety Trust - brief history of federal pipeline safety laws
https://pstrust.org/a-brief-history-of-federal-pipeline-safety-laws/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 18.

Supports: Natural Gas Pipeline Safety Act of 1968 was the first statute.

163. EIA - FERC Order 636
https://www.eia.gov/oil_gas/natural_gas/analysis_publications/ngmajorleg/ferc636.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 18.

Supports: Restructuring Rule issued 8 April 1992.

164. FERC - Order No. 636, Restructuring of Pipeline Services
https://www.ferc.gov/order-no-636-restructuring-pipeline-services

Status: *Read*. Cited in chapter 18.
Supports: Unbundling of sales and transportation; unbundled no-notice and firm transportation and storage; capacity release.

165. Oxford Institute for Energy Studies - NG 49
https://www.oxfordenergy.org/wpcms/wp-content/uploads/2011/03/NG49.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 18.
Supports: Take-or-pay obligations in oil-indexed contracts; hybrid price market from about the end of 2008.

166. CME Group - Henry Hub natural gas futures
https://www.cmegroup.com/articles/whitepapers/henry-hub-natural-gas-futures-global-benchmark.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 19.
Supports: Henry Hub in Erath, Louisiana, a nexus of interstate and intrastate pipelines.

167. The Oklahoman - natural gas futures trading starts today (3 April 1990)
https://eu.oklahoman.com/story/news/1990/04/03/natural-gas-futures-trading-starts-today/62570001007/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 19.
Supports: NYMEX natural gas futures began trading 3 April 1990 with Henry Hub at the Sabine interchange near Lafayette.

168. EIA Natural Gas Issues and Trends - High prices show stresses in New England natural gas delivery system (7 February 2014)
https://www.eia.gov/naturalgas/review/deliverysystem/2013/

Status: *Read*. Cited in chapter 19.
Supports: Tennessee and Algonquin pipelines carry about 3.5 Bcf/d into New England; capacity exceeds average January consumption but peak days set the stress; January 2014 forward basis $17.41 against Henry Hub; December 2013 bidweek $14.52.

169. EIA Today in Energy - New England spot natural gas prices hit record levels this winter (21 February 2014)
https://www.eia.gov/todayinenergy/detail.php?id=15111

Status: *Read*. Cited in chapter 19.

Supports: Algonquin Citygate spot averaged $22.53/MMBtu 1 January to 18 February 2014, record since 2001 series; February 2014 bidweek $33.79; LNG deliveries down more than 30 per cent and major pipelines congested.

170. Gasunie - TTF, Dutch gas trading platform
https://www.gasunie.nl/en/gas-infrastructure/ttf---dutch-gas-trading-platform

Status: *Read*. Cited in chapter 19.

Supports: TTF set up in 2003 as a virtual transfer point inside the transport network; largest traded volume in Europe; more than eighty times Dutch consumption.

171. European Commission - Quarterly report on European gas markets, Q2 2022
https://commission.europa.eu/system/files/2022-10/quarterly_report_on_european_gas_markets_q2_2022_final_0.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 19.

Supports: Daily TTF spot peaked in March 2022, mostly below 100 EUR/MWh in April and May, rose again in June, all-time high 316 EUR/MWh on 26 August 2022.

172. IEA - Fast-tracking gas market reforms
https://www.iea.org/commentaries/fast-tracking-gas-market-reforms

Status: *Read*. Cited in chapter 19.

Supports: Share of oil-indexation in Europe's import prices fell from above 90 per cent in 2005 to below 25 per cent in 2019; shift to hybrid and hub-indexed formulae.

173. S&P Global - Platts JKM (Japan Korea Marker) LNG price assessment explained
https://www.spglobal.com/energy/en/pricing-benchmarks/assessments/lng/jkm-japan-korea-marker-gas-price-explained

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 19.

Supports: JKM is a benchmark assessment of spot LNG cargoes delivered ex-ship to Japan, South Korea, China and Taiwan, assessed by a market-on-close process; referenced in spot and term contracts.

174. GIIGNL - Contracts
https://giignl.org/market-trends/contracts/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 19.

Supports: Recently signed LNG contracts are priced against a variety of indices: oil, JKM, TTF, AECO, mixed.

175. EIA - Natural gas spot prices fell across key regional trading hubs in 2024
https://www.eia.gov/TODAYINENERGY/detail.php?id=64445

Status: *Read*. Cited in chapter 19.

Supports: Waha Hub traded below zero for 42 percent of trading days in 2024 as Permian output outpaced pipeline takeaway capacity.

176. Reuters - Texas natural gas pipeline eases bottleneck
https://www.reuters.com/business/energy/texas-natural-gas-pipeline-eases-bottlenecks-paves-way-higher-shale-output-2024-10-18/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 19.

Supports: Matterhorn Express, 580 miles, first new large gas pipeline out of the Permian in years.

177. Matterhorn Express Pipeline - project overview (owner website)
https://matterhornexpress.com/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 19.

Supports: Approximately 580-mile intrastate pipeline, up to 2.5 Bcf/d, Permian Basin to the Katy area near Houston.

178. EIA - Natural gas pipeline project completions increase takeaway capacity (2024 projects)
https://www.eia.gov/tODAyinenergy/detail.php?id=64744

Status: *Read*. Cited in chapter 19.

Supports: Matterhorn Express, operated by WhiteWater, can deliver up to 2.5 Bcf/d from the Permian to the Katy, Texas area.

179. IEEFA comments on the Constitution pipeline
https://ieefa.org/resources/ieefa-comments-proposed-constitution-pipeline-project

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 20.
Supports: A FERC certificate of public convenience and necessity empowers a company to use eminent domain.

180. US Supreme Court - PennEast Pipeline Co. v. New Jersey, No. 19-1039 (29 June 2021), syllabus
https://www.supremecourt.gov/opinions/20pdf/19-1039%5F8n5a.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 20.
Supports: Section 717f(h) authorizes FERC certificate holders to condemn all necessary rights-of-way, whether owned by private parties or States; 5-4 per CRS.

181. Congressional Research Service - PennEast Pipeline Company v. New Jersey (LSB10634)
https://www.congress.gov/crs_external_products/LSB/HTML/LSB10634.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 20.
Supports: 5-4 decision; Section 7 permits pipeline companies to bring condemnation proceedings against states in federal court.

182. Wikipedia - Mountain Valley Pipeline
https://en.wikipedia.org/wiki/Mountain_Valley_Pipeline

Status: *Read*. Cited in chapter 20.
Supports: About 303 miles; up to 2 bcf a day; crosses the Appalachian Trail; years behind schedule.

183. VPM - Mountain Valley Pipeline cost (3 December 2024)
https://www.vpm.org/news/2024-12-03/mountain-valley-pipelines-cost-10-billion/

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 20.
Supports: First estimated at $3.5 billion in 2018; cost almost $10 billion per a regulatory filing.

184. CRS - Mountain Valley Pipeline litigation tests Congress's power to limit federal court jurisdiction (LSB11010)
https://www.congress.gov/crs-product/LSB11010

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 20.

Supports: Section 324 of the Fiscal Responsibility Act of 2023 directed agencies to issue permits and limited court jurisdiction over challenges.

185. NPR - Debt ceiling deal bulldozes Mountain Valley Pipeline's path through courts (31 May 2023)
https://www.npr.org/2023/05/31/1179201992/mountain-valley-pipeline-west-virginia-debt-ceiling-deal

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 20.

Supports: FRA orders expedited approval of permits; opposed by climate and conservation groups and residents.

186. Mountain Valley Pipeline - MVP Mainline Project (operator website)
https://www.mountainvalleypipeline.info/

Status: *Read*. Cited in chapter 20.

Supports: MVP entered service on 14 June 2024; capacity fully subscribed under long-term binding contracts.

187. Associated Press - Atlantic Coast Pipeline cancelled (5 July 2020)
https://apnews.com/article/5e4dec29b0da663e6243a71aea016940

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 20.

Supports: Cancelled by Dominion and Duke; about $8 billion; cost, permitting and litigation uncertainty.

188. Utility Dive - Duke and Dominion cancel Atlantic Coast Pipeline
https://www.utilitydive.com/news/duke-dominion-cancel-8b-atlantic-coast-pipeline/581028/

Status: *Read*. Cited in chapter 20.

Supports: Estimates rose from $4.5 billion to $8 billion after legal challenges.

189. US Court of Appeals, Second Circuit - Constitution Pipeline Co. v. NYSDEC, No. 16-1568 (18 August 2017)
https://ag.ny.gov/sites/default/files/2017_08_18_constitution_decision.pdf

Status: *Read*. Cited in chapter 20.

Supports: 121-mile interstate line, about 98 miles in New York; NYSDEC denied Clean Water Act section 401 certification by letter of 22 April 2016; court lacked jurisdiction over the timeliness challenge and held the denial within statutory authority and not arbitrary or capricious.

190. FERC - An Interstate Natural Gas Facility on My Land? What Do I Need to Know?
https://ferc.gov/interstate-natural-gas-facility-my-land-what-do-i-need-know

Status: *Read*. Cited in chapter 20.

Supports: Company negotiates easement and compensation with each landowner; construction right-of-way generally 75 to 100 feet, permanent about 50 feet; landowner keeps title and pays taxes; deep-rooted trees and obstructions to aerial inspection generally not allowed on the right-of-way.

191. CBC News - What you need to know about the Coastal GasLink pipeline conflict
https://www.cbc.ca/news/indigenous/wet-suwet-en-coastal-gaslink-pipeline-1.5448363

Status: *Read*. Cited in chapter 20.

Supports: 670 km, $6 billion; 20 First Nations band councils signed agreements including five of six Wet'suwet'en band councils; hereditary chiefs dispute the councils' authority outside reserves; interim injunction December 2018; Justice Church's interlocutory injunction 31 December 2019.

192. Louisiana DNR - Pipeline Safety Program history
https://www.denr.louisiana.gov/page/psp-safety-program-history

Status: *Read*. Cited in chapter 21.

Supports: 4 March 1965, 24-inch Tennessee Gas line near Natchitoches, 17 killed; credited as a spur to the 1968 Act.

193. The New York Times - Blast fatal to 17 in Louisiana city (5 March 1965)
https://www.nytimes.com/1965/03/05/archives/blast-fatal-to-17-in-louisiana-city-pipeline-explodes-spraying.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 21.

Supports: Seventeen killed, nine of them children (UPI).

194. Oil & Gas Journal - OPS review addresses SCC threat to pipeline integrity
https://www.ogj.com/general-interest/hse/article/17236189/ops-review-addresses-scc-threat-to-pipeline-integrity

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 21.
Supports: First known SCC case on a buried pipeline identified after Natchitoches 1965.

195. NTSB - Natural gas pipeline rupture and fire near Carlsbad, New Mexico, 19 August 2000 (PAR-03/01)
https://www.ntsb.gov/investigations/AccidentReports/Reports/PAR0301.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 21.
Supports: 30-inch El Paso line ruptured beside the Pecos River at 5:26 a.m.; burned 55 minutes; twelve campers killed.

196. NTSB - Carlsbad investigation DCA00MP009
https://www.ntsb.gov/investigations/Pages/DCA00MP009.aspx

Status: *Read*. Cited in chapter 21.
Supports: Probable cause: severe internal corrosion; the corrosion control program failed to prevent, detect or control it.

197. French ARIA accident database - Ghislenghien
https://www.aria.developpement-durable.gouv.fr/fiche_detaillee/27681_en/?lang=en

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 21.
Supports: Pipeline buried 1.10 m below the surface.

198. Wikipedia - Ghislenghien disaster
https://en.wikipedia.org/wiki/Ghislenghien_disaster

Status: *Read*. Cited in chapter 21.
Supports: 30 July 2004; damage from construction work.

199. Belgium.be news - Ghislenghien one year after the catastrophe (in French)
https://news.belgium.be/fr/ghislenghien-un-apres-la-catastrophe-un-apercu

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 21.
Supports: 24 dead and 132 injured.

200. RFE/RL - Ufa train disaster, 30 years on (2019)
https://www.rferl.org/a/ufa-train-disaster/29972680.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 21.

Supports: Official figures: 575 killed, 800 injured; gas leaked from a nearby pipeline exploded as two trains passed; estimated at 10,000 tons of TNT.

201. Case Western Reserve - Encyclopedia of Cleveland History: East Ohio Gas Co. explosion and fire
https://case.edu/ech/articles/e/east-ohio-gas-co-explosion-and-fire

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 21.

Supports: 20 October 1944: a tank holding liquid natural gas equivalent to 90 million cubic feet exploded, causing the worst fire in Cleveland's history.

202. Wikipedia - Cleveland East Ohio Gas explosion
https://en.wikipedia.org/wiki/Cleveland_East_Ohio_Gas_explosion

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 21.

Supports: 20 October 1944; 131 killed; LNG plant built 1940.

203. IEA - Global Methane Tracker 2025
https://www.iea.org/reports/global-methane-tracker-2025

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 22.

Supports: Methane responsible for around 30 percent of temperature rise since the Industrial Revolution.

204. IEA - Global Methane Tracker 2025, understanding methane emissions
https://www.iea.org/reports/global-methane-tracker-2025/understanding-methane-emissions

Status: *Read*. Cited in chapter 22.

Supports: 610 Mt global; energy 145 Mt in 2024; oil about 45 Mt; natural gas nearly 35 Mt; upstream about 85 percent of oil and gas methane.

205. EPA - Subpart W information sheet
https://www.epa.gov/ghgreporting/subpart-w-information-sheet

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 22.

Supports: Facilities must report methane from equipment leaks and vented emissions.

206. MethaneSAT - first look system-wide view
https://www.methanesat.org/project-updates/first-look-system-wide-view

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 22.
Supports: Emissions intensity varies by region, age of infrastructure, practices and pipeline takeaway capacity.

207. Salzgitter - Nord Stream and EUROPIPE sign 1 billion euro contract
https://www.salzgitter-ag.com/en/newsroom/press-releases/details/pipeline-across-the-baltic-sea-nord-stream-and-europipe-sign-1-billion-euro-contract-1978.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 23.
Supports: EUROPIPE to supply 75 percent of the pipes for the first 1,200 km line; Russian OMK (Vyksa) awarded the rest.

208. KyivPost - Nord Stream 2 selects Europipe, OMK, Chelpipe (12 March 2016)
https://archive.kyivpost.com/article/content/ukraine-politics/nord-stream-2-selects-europipe-omk-chelpipe-to-supply-pipe-construction-to-begin-in-2018-409851.html

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 23.
Supports: About 2,500 km of pipe, about 2.2 million tonnes: Europipe 40 percent, OMK 33 percent, and Chelpipe.

209. Allseas - Nord Stream 2 awards pipelay contract to Allseas
https://www.allseas.com/en/who-we-are/news-and-media/nord-stream-2-awards-pipelay-contract-allseas

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.
Supports: Allseas awarded offshore pipelay of both Nord Stream 2 lines in 2018-2019, using Pioneering Spirit, Solitaire and Audacia.

210. Allseas - Solitaire
https://www.allseas.com/en/who-we-are/our-fleet/solitaire

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.
Supports: Pipelay vessel launched 1998.

211. Nord Stream AG - Construction of Line 2 completed in Russia
https://www.nord-stream.com/press-info/press-releases/construction-of-line-2-of-the-nord-stream-pipeline-is-completed-in-russia-342/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.

Supports: Pipelay vessel Solitaire finished 116 km of Line 2 in Russian waters.

212. Kinder Morgan - Natural gas operations
https://kindermorgan.com/Operations/Natural-Gas/Index

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.

Supports: Company statement: about 65,000 miles of natural gas pipelines owned in part or operated; about 40 percent of US-produced gas.

213. OGE - OGE in Europe
https://oge.net/en/we/company/oge-in-europe

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.

Supports: 12,000-kilometre transmission network, the largest in Germany.

214. Snam Sustainability Report 2018 - presence in national and international infrastructure
https://reports.snam.it/2018/sustainability-report/snams-profile/snams-presence-in-the-national-and-international-infrastructure-system.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 23.

Supports: 20 December 2018: Snam 60 percent, Enagas 20, Fluxys 20 bought 66 percent of Greek operator DESFA.

215. IEA - ammonia technology roadmap
https://www.iea.org/reports/ammonia-technology-roadmap/executive-summary

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 24.

Supports: About 70 percent of ammonia is used for fertilisers.

216. European Commission - fertilisers market brief
https://agriculture.ec.europa.eu/system/files/2019-07/market-brief-fertilisers_june2019_en_0.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 24.

Supports: Haber-Bosch process, about a century old, fixes nitrogen from air with hydrogen at high temperature and pressure.

217. Fertilizers Europe - Europe's fertilizer industry victim of EU's energy chaos (26 August 2022)
https://www.fertilizerseurope.com/wp-content/uploads/2022/08/Fertilizers-Europe-Press-release_Europe-fert-industry-victim-of-EU-energy-chaos-1.pdf

Status: *Passage verified against the book sentence in a secondary or reference source; the origin is upstream*. Cited in chapter 24.

Supports: Industry claim: gas 8-10 times costlier in Europe than in the US; majority of European fertilizer production curtailed or shut.

218. European Parliament written question E-003632/2022 citing CRU Group
https://www.europarl.europa.eu/doceo/document/E-9-2022-003632_EN.html

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 24.

Supports: CRU estimate quoted in the question: about half of European ammonia production and 33 percent of nitrogen fertiliser plant closed.

219. IEA - Global Energy Review 2025, natural gas
https://www.iea.org/reports/global-energy-review-2025/natural-gas

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 24.

Supports: Industry and electricity generation accounted for around 75 percent of incremental gas demand in 2024.

220. US Energy Information Administration - Use of natural gas
https://www.eia.gov/energyexplained/natural-gas/use-of-natural-gas.php

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 24.

Supports: 2023 US gas consumption by sector: electric power 12.93 Tcf 40%, industrial 10.51 Tcf 32%, residential 4.48 Tcf 14%, commercial 3.31 Tcf 10%, transportation 1.27 Tcf 4%; gas about 43% of utility-scale electricity; 41% of residential end-use energy.

221. IEA - Gas 2025 executive summary
https://www.iea.org/reports/gas-2025/executive-summary

Status: *Passage verified against the book sentence in the owning source*. Cited in chapters 24, 25.
Supports: Demand growth 2.8 percent in 2024, below 1 percent in 2025; US and Qatar 70 percent of about 300 bcm/yr new LNG capacity.

222. US Energy Information Administration - Liquefied natural gas
https://www.eia.gov/energyexplained/natural-gas/liquefied-natural-gas.php

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 25.
Supports: LNG about -260 F, volume about 600 times smaller; regasification and peak shaving; US exports 2016 to 2023 (capacity about 1 to 11.44 Bcf/d; exports 0.5 to 11.90 Bcf/d, 17 to 43 countries, 57 percent of gas exports); 7 to 15 percent of feed gas used in liquefaction.

223. International Gas Union - 2025 World LNG Report
https://www.igu.org/igu-reports/2025-world-lng-report

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 25.
Supports: Global LNG trade grew 2.4 percent in 2024 to 411.24 Mt, 22 exporting and 48 importing markets; European LNG imports fell 21.22 Mt to 100.07 Mt.

224. IEA - Gas Market Report Q1-2025, executive summary
https://www.iea.org/reports/gas-market-report-q1-2025/executive-summary

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 25.
Supports: Global LNG supply grew 2.5 percent (13 bcm) in 2024, well below 8 percent average growth in 2016-2020.

225. CEDIGAZ - First estimates 2025
https://www.cedigaz.org/cedigaz-first-estimates-2025/

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 25.
Supports: 2024 global gas demand about 4166 bcm, growth 2.9 percent.

226. European Hydrogen Backbone initiative
https://www.natrangroupe.com/en/medias/press-releases/european-hydrogen-backbone

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 26.

Supports: 39,700 km vision in 21 countries; two-thirds repurposed natural gas pipelines.

227. US DOE - HyBlend: Opportunities for hydrogen blending in natural gas pipelines (technical summary)
https://www.energy.gov/sites/default/files/2022-12/hyblend-tech-summary-120722.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 26.

Supports: Blend limits depend on pipeline materials and condition, compressor stations and end-use equipment, and vary greatly.

228. NREL - Impacts of hydrogen blending in natural gas networks (CRADA final report)
https://docs.nlr.gov/docs/fy23osti/85061.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 26.

Supports: Transmission pipelines use low-carbon high-strength steel; hydrogen embrittlement is complicated and difficult to detect.

229. US DOE Hydrogen Program review - what we know about H2 compatibility
https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/review23/fe016_kass_2023_p-pdf.pdf

Status: *Passage verified against the book sentence in the owning source*. Cited in chapter 26.

Supports: H2 embrittlement of pipeline steels extensively studied; ASME B31.12 recommends maximum grade X52.