THE STEAM TURBINE

Source Companion

Every source cited in The Steam Turbine: Heat, Spin, Current, with what it supports and how it was read.

The Steam Turbine: Source Companion
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This companion lists every source cited in The Steam Turbine: Heat, Spin, Current, in citation order. For each source it gives the reference, the specific claims it supports, an honest statement of how it was read, and its limitations. Bracketed references in the main text ([T1], [T2], ...) resolve here. Web sources were accessed on 1 November 2026 unless noted otherwise.

[T1] Nature, Vol. 142 (10 December 1938), "The Parsons Steam Turbine" (doi:10.1038/1421025a0)

- Read level: search-result excerpt covering the Turbinia narrative in detail.
- Supports: Turbinia's 1894 build (100 ft, 44 tons, single radial turbine, 1,650 hp design, 1,600-1,700 rpm); disappointing early trials under 20 knots; 31 propeller trials; power-cube analysis (8:27 shortfall); first marine torsionmeter; Thornycroft/Barnaby cavitation observation (~11.5 lb/sq in loading limit vs Turbinia's 60); three turbines/three shafts/nine propellers; Feb 1896 32.5 knots, later 34 knots; Marine Steam Turbine Company directors; King Edward 1901; Queen, Brighton, Princess Maud, Londonderry, Lhasa/Linga/Lama/Lunka; Lusitania, Mauretania, Dreadnought closing the first decade.
- Limitations: excerpt, not the full article text; 1938 retrospective.
- https://doi.org/10.1038/1421025a0

[T2] ASME, "Turbinia (1897)", Engineering History Landmarks

- Read level: full page.
- Supports: world's first turbine-driven ship; 1897 Spithead Naval Review at more than 34 knots; Parsons (1854-1931) invented 1884; accelerated turbine acceptance ashore and afloat.
- Limitations: short institutional summary.
- https://www.asme.org/about-asme/engineering-history/landmarks/73-turbinia

[T3] Wikipedia, "Turbinia"

- Read level: full article (search excerpts).
- Supports: built by Brown and Hood, Wallsend; launched 2 August 1894; Parsons Marine Steam Turbine Company 1897; direct drive (gearing from 1910); Viper and Cobra launched 1899, lost 1901; Admiralty 1905 decision that all future RN vessels be turbine-powered; Dreadnought 1906 first turbine battleship; Paris 1900 showing; museum homes (Discovery Museum Newcastle; Science Museum London).
- Limitations: tertiary; some claims rely on standard naval histories.
- https://en.wikipedia.org/wiki/Turbinia

[T4] Gustaf de Laval, US Patent 285,584, "Turbine for Steam and Other Motive Power", granted 25 September 1883 (Wikisource transcription)

- Read level: full specification text.
- Supports: 1883 filing/grant dates; de Laval of Stockholm; early turbine arrangement with curved tubes, reaction drive and friction bevel gearing.
- Limitations: primary document; describes the early embodiment, not the mature bucket-wheel impulse machine.
- https://en.wikisource.org/wiki/United_States_patent_285584

[T5] Guinness World Records, "Most powerful steam turbine generator"

- Read level: full page.
- Supports: 1750 MWe Arabelle built by Alstom (France); ordered by EDF 2006; for Flamanville 3; 1,750 MW maximum.
- Limitations: record page; reflects 2006-order context.
- https://www.guinnessworldrecords.com/world-records/113425-most-powerful-steam-turbine-generator

[T6] Arabelle Solutions, "Arabelle turbine for large reactors"

- Read level: full page.
- Supports: most powerful nuclear steam turbine in operation; suits 700-1,900 MW reactors; 50+ units delivered or on order; 2% more output than traditional configurations; 99.96% reliability figure; 1,900 MW maximum; 75-inch last-stage blade.
- Limitations: manufacturer marketing page; reliability figure is the maker's own.
- https://www.arabellesolutions.com/en/our-technology/pioneering-steam-turbines/arabelle-turbine-for-large-reactors

[T7] Grand View Research, "Steam Turbine Market"

- Read level: full page summary.
- Supports: market valued USD 19.6B (2025), USD 20.7B (2026 estimate), USD 29.4B (2033 forecast), CAGR 5.1% (2026-2033); Asia Pacific dominant by revenue share in 2025; demand driver: new power plants.
- Limitations: commercial market research; figures are modelled estimates; segmentation detail behind paywall.
- https://www.grandviewresearch.com/industry-analysis/steam-turbine-market

[T8] Wikipedia, "Steam turbine"

- Read level: full article (fetched in full, 1 November 2026).
- Supports: Parsons as inventor of the modern steam turbine 1884; 7.5 kW (10.1 hp) first model; ~10,000x unit scale-up within Parsons' lifetime to 50,000 kW; impulse vs reaction taxonomy; Curtis/Rateau/Brown-Curtis naming; nozzle enthalpy-drop theory and velocity-triangle efficiency (eta_max = cos^2 alpha); de Laval impulse characteristics; Verbiest 1672 steam-jack car; Watt's 1775 Soho reaction turbine; Taqi al-Din and Wilkins steam jacks; anatomy (casings, rotors, blades, glands, bearings, condenser, governors).
- Limitations: tertiary; some entries carry [citation needed] flags, which this book avoids relying on.
- https://en.wikipedia.org/wiki/Steam_turbine

[T9] Ember, Global Electricity Review 2025 and Electricity Data Explorer

- Read level: report page, data-explorer page and a Reuters report of the review.
- Supports: world generation about 31,924 TWh in 2025; coal largest source at 33.2% (2025); renewables record 32% of global electricity in 2024.
- Limitations: 2025 figures partly estimated from monthly data; renewables share includes hydro.
- https://ember-energy.org/latest-insights/global-electricity-review-2025/ ; https://ember-energy.org/data/electricity-data-explorer/

[T10] Wikipedia, "Aeolipile" (fetched in full)

- Read level: full article.
- Supports: Hero's aeolipile construction and operation; Pneumatica context of temple devices; manuscript survival and Renaissance re-circulation; absence of practical use in antiquity and the standard explanations (materials, gearing, labour economy).
- Limitations: tertiary; dating of Hero's life is approximate by nature.
- https://en.wikipedia.org/wiki/Aeolipile

[T11] Wikipedia, "Taqi al-Din Muhammad ibn Ma'ruf" (fetched in full)

- Read level: full article.
- Supports: c.1551 description in al-Turuq al-samiyya fi al-alat al-ruhaniyya (The Sublime Methods of Spiritual Machines) of steam directed at vanes to turn a roasting spit; Ottoman observatory context.
- Limitations: tertiary; survival/impact of the device beyond the manuscript is not documented.
- https://en.wikipedia.org/wiki/Taqi_al-Din_Muhammad_ibn_Ma%27ruf

[T12] Wikipedia, "Thomas Savery" / "Newcomen atmospheric engine" (fetched in full)

- Read level: full articles.
- Supports: Savery's Miner's Friend; 1698 patent with 1699 Parliamentary extension to 1733; no moving parts; high hopes and practical disappointment.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Thomas_Savery

[T13] Wikipedia, "Newcomen atmospheric engine" (fetched in full)

- Read level: full article.
- Supports: 1712 Conygree Coalworks engine near Dudley Castle, Tipton; atmospheric working principle (condensation making vacuum, air pressure driving the piston); slow speed and very low efficiency; spread through British and continental mining.
- Limitations: tertiary; early-engine details rest on few engravings and later reconstructions.
- https://en.wikipedia.org/wiki/Newcomen_atmospheric_engine

[T14] Wikipedia, "Watt steam engine" (fetched in full)

- Read level: full article.
- Supports: Watt's 1763-64 model-engine measurements; separate condenser idea (Glasgow Green, 1765); 1769 patent; ~75% fuel saving vs Newcomen; Roebuck's bankruptcy; Boulton & Watt partnership 1775; sun-and-planet gear, double-acting cylinder, centrifugal governor; rotative engines enabling factories.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Watt_steam_engine

[T15] Wikipedia, "Rankine cycle" (fetched in full)

- Read level: full article.

- Supports: four-step cycle description (pump, boiler, turbine, condenser); reheat and regenerative feed heating; ORC as steam turbines on low-boiling fluids; steam bottoming cycles in combined-cycle plants.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Rankine_cycle

[T16] Wikipedia, "Gustaf de Laval" (fetched in full)

- Read level: full article.
- Supports: born 1845; Uppsala doctorate; cream separator 1878; company founded with Oscar Lamm 1883 (later Alfa Laval); 1890 convergent-divergent (de Laval) nozzle for supersonic steam jets; nozzle's later use in rocket engines; milking-machine patent 1894; died 1913.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Gustaf_de_Laval

[T17] Wikipedia, "Charles Algernon Parsons" (fetched in full)

- Read level: full article.
- Supports: born 1854, son of the Earl of Rosse; Cambridge mathematics; Clarke Chapman partnership; 1884 turbine at 18,000 rpm driving his own dynamo; 1.6% first efficiency; Newcastle and District Electric Lighting Company; Forth Banks 1890 first turbo-generator power station; patent loss and 1894 recovery; C. A. Parsons & Co 1889; death 1931; 50 MW units by then.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Charles_Algernon_Parsons

[T18] Wikipedia, "Steam turbine" - compounding taxonomy (with [T8])

- Read level: full article sections.
- Supports: Rateau pressure-compounded impulse; Curtis velocity-compounded impulse ("Curtis wheel"); Brown-Curtis naming; modern practice of impulse control stage + reaction blading.
- Limitations: tertiary; see [T8].
- https://en.wikipedia.org/wiki/Steam_turbine

[T19] Wikipedia, "History of thermodynamics" and "Nicolas Leonard Sadi Carnot" (fetched in full)

- Read level: full articles.
- Supports: Carnot's Reflections June 1824, 600 copies printed at author's expense by Bachelier; father-of-thermodynamics status; Joule 1843 mechanical equivalent and 1845 paddle-wheel; Kelvin absolute scale; Clausius entropy and second law; Carnot limit formula.
- Limitations: tertiary; the Henderson attribution ("science owes more to the steam engine...") is presented in the book as attributed, not verified verbatim.
- https://en.wikipedia.org/wiki/History_of_thermodynamics ; https://en.wikipedia.org/wiki/Nicolas_L%C3%A9onard_Sadi_Carnot

[T20] Richard Mollier's enthalpy-entropy diagram (1904) - Wikipedia, "Richard Mollier" (fetched in full) - Read level: full article. - Supports: Mollier (1863-1935), professor at Dresden

from 1897; 1904 publication "New Graphs for Technical Thermodynamics" simplifying thermodynamic calculation; 1906 "New Tables and Diagrams for Water Vapor"; 1923 Los Angeles thermodynamics conference naming enthalpy-axis diagrams "Mollier graphs"; routine use of the h-s chart in steam turbine design work. - Limitations: tertiary; the original 1904 publication itself was not read. - https://en.wikipedia.org/wiki/Richard_Mollier

[T21] Wikipedia, "Aurel Stodola" (fetched in full)

- Read level: full article.
- Supports: born 11 May 1859, Liptovsky Mikulas; ETH (Federal Polytechnic) Zurich professor from 1892; Die Dampfturbinen 1903; English translation 1927, reprinted to 1945; reference for first US jet-engine work; scope (fluid flow, vibration, disc stress).
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Aurel_Stodola

[T22] Efficiency-ladder figures

- Read level: assembled. Newcomen <1% and Watt ~75% fuel saving: [T13]/[T14]. Cornish 10-17%: standard histories, consistent with duty figures in [T43]. Parsons 1.6%: [T17]. Mature 1920s-1950s values: standard literature, tertiary. Modern 45%+: [T39].
- Limitations: mid-century rungs are approximate by nature; flagged as approximate in the book's table.

[T23] Author's synthesis statements

- Supports: statements identified in text as synthesis or forecast (grid inertia narrative, order-book reading, "comfortably more than half" share arithmetic).
- Method: arithmetic on [T9] figures and cited programme facts; no external source claimed.

[T24] Steam turbine engineering practice (casings, rotors, glands, bearings, condensers, governors, testing)

- Read level: corroborated across [T8] plus manufacturer technical literature ([T25], [T26]) and standard texts; no single source read cover-to-cover.
- Limitations: practice-level description; specific dimensions vary by maker.

[T25] Siemens Energy, Industrial Steam Turbines brochure (SST range, PDF)

- Read level: search excerpts of the brochure.
- Supports: industrial range 2-250 MW; SST-800 dual-casing reheat machine; 180 bar(a) live steam; 3,000/3,600 rpm.
- Limitations: marketing document.
- https://assets.siemens-energy.com/dam/f005e344-5c84-41b0-b378-b20600c62b67/SE_Brochure-Industrial-Steam-Turbines_240611-pdf_Original%20file.pdf

[T26] GE Vernova, Steam Power services pages and services catalog (PDF)

- Read level: page and catalog excerpts.
- Supports: thousands of steam turbines supported worldwide; parts supply, outage support, root-cause analysis, digital monitoring and predictive maintenance; industrial steam turbine lines.
- Limitations: marketing material.

- https://www.gevernova.com/steam-power/services/steam-turbines

[T27] Marine adoption synthesis

- Read level: built from [T1], [T2], [T3], [T48], [T49], [T50].
- Supports: turbo-electric history, liners' genealogy, diesel displacement narrative, naval nuclear steam.
- Limitations: synthesis of tertiary sources; specific ship figures attributed where stated.

[T28] Wikipedia, "Supercritical steam generator" (fetched in full)

- Read level: full article.
- Supports: critical point 22.10 MPa / 374 C (3,206 psi / 706 F); Mark Benson; 1927 test boiler in service at Gartenfeld, Berlin, from 1929; once-through no-drum principle.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Supercritical_steam_generator

[T29] Wikipedia, "Ljungstrom turbine" (fetched in full)

- Read level: full article.
- Supports: radial-flow counter-rotating twin-disc design; condensing or district-heating exhaust; coupling with Parsons machines to about 50 MW; niche persistence.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Ljungstr%C3%B6m_turbine

[T30] Wikipedia, "Fisk Generating Station" (fetched in full)

- Read level: full article.
- Supports: in service 2 October 1903; Chicago Edison (Insull chairman, Sargent chief engineer); 5 MW (11,000 hp) GE Curtis turbo-generator Unit 1; GE's prior 600 kW units; Coffin-Insull risk arrangement and Insull's quote; unit returned to Schenectady as monument; ASME landmark 1975.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Fisk_Generating_Station

[T31] Combined-cycle efficiency records

- Read level: Guinness record page; GE press release; Modern Power Systems report (search excerpts).
- Supports: GE 9HA.02 at more than 64% net combined-cycle efficiency; Keadby 2 as Europe's most efficient combined-cycle plant; steam bottoming principle ([T15]).
- Limitations: manufacturer-claimed figures certified by Guinness process.
- https://www.ge.com/news/press-releases/ha-technology-now-available-industry-first-64-percent-efficiency

[T32] LNG Atlas, "LNG carrier steam turbine propulsion - why it lasted for decades"

- Read level: full explainer.
- Supports: steam plant burning cargo boil-off gas, fuel oil, or any mixture; geared turbine to single shaft; reason for steam's longevity in the LNG trade.
- Limitations: specialist explainer site.

- https://lngatlas.org/explainer/lng-propulsion-steam/

[T33] Mitsubishi Heavy Industries Technical Review Vol. 44 No. 3 (2007), "Development of High Efficiency Marine Propulsion Plant (Ultra Steam Turbine)"

- Read level: abstract and excerpts.
- Supports: UST 15% more efficient than conventional marine steam plant while retaining reliability/maintainability; DFE and DRL competition; first DFE ship built in France; oil-price pressure on LNG propulsion choices.
- Limitations: manufacturer technical marketing.
- https://www.mhi.com/technology/review/sites/g/files/jwhtju2326/files/tr/pdf/e443/e443015.pdf

[T34] Calpine / The Geysers, "About The Geysers"

- Read level: full page.
- Supports: largest geothermal electrical operation in the world; 13 plants; 45 square miles; approximately 725 MW; 1920 first exploratory well; 1960 first large-scale US geothermal plant; enough for a city the size of San Francisco.
- Limitations: operator page.
- https://geysers.com/about/

[T35] Larderello primacy - see [T52] [T36] CSP examples - see [T53], [T54] [T37] Industry genealogy synthesis from [T8], [T17], [T5], [T57], [T56], [T26]; corporate transactions dated in text are stated as tertiary.

[T38] Bharat Heavy Electricals, official site, "Offerings across major businesses" and product profile

- Read level: page excerpts.
- Supports: steam turbines and turbo-generators up to 1,000 MW unit rating; supercritical sets at 350/660/700/800 MW; subcritical to 600 MW; condensers, feed heaters, valves; residual life assessment and renovation/modernisation business.
- Limitations: manufacturer page.
- https://www.bhel.com/offerings-across-major-businesses

[T39] Ultra-supercritical and AUSC technical literature (search excerpts)

- Read level: abstracts/excerpts of: Stume Journals MTM 2021 analysis of a 500 MW USC plant (300 bar/600 C, reheat 610 C/50 bar, condenser 0.039 bar; 47.39% gross / 45.14% net; 733.4 kg CO2/MWh; +9 pts vs subcritical); AUSC review (subcritical 34-40% LHV, global average ~36%; SC 42-45%; record 47.5% net at RDK Block 8, 600/620 C, 275 bar; AUSC toward ~50% at 700 C/350 bar with Cr/Ni/Co/V/W/Mo alloy development).
- Supports: the efficiency ladder's modern rungs; USC parameter definitions; AUSC targets labelled as expected/forecast.
- Limitations: academic modelling and reviews; fleet-average values differ by country.
- https://stumejournals.com/journals/mtm/2021/1/28.full.pdf ; https://doi.org/10.2478/v10173-011-0025-1

[T40] The Japan Steel Works, product pages and technical papers

- Read level: product page and paper abstracts/excerpts.

- Supports: monoblock rotor shafts; 14,000-ton press; shafts from 600-ton ingots; 670-ton ingot technique described as world's largest; high-chromium ferritic steels for USC; trial manufacture of 10-ton-class A-USC Ni-Fe superalloy rotors with fine grain and ultrasonic inspectability.
- Limitations: manufacturer material.
- https://www.jsw.co.jp/en/product/business/material_engineering/me_0500/

[T41] World Nuclear News, "Nuclear component orders bolster JSW results" (fetched in full) + Saarstahl/Saarschmiede official pages

- Read level: full article; official company pages.
- Supports: JSW's ~80% world market share in large nuclear forgings (reactor vessels, steam generators, turbine shafts); Muroran, Hokkaido presses to 14,000 tonnes taking 600-tonne ingots; global very-heavy forging map: China First Heavy Industries and China Erzhong, OMZ Izhora, Doosan (Korea), Le Creusot (France), Sheffield Forgemasters (UK); capacity expansions under order pressure. Saarschmiede (Volklingen, Germany) confirmed by its owner Saarstahl as "one of the largest and most advanced open-die forges in the world," producing large turbine shafts for power generation machinery.
- Limitations: the WNN article dates from the 2009-2010 nuclear order wave; the book presents the 2020s constraint as reported lead-time pressure corroborated by [T59]/[T60], not as a quantified forge census.
- https://world-nuclear-news.org/articles/nuclear-component-orders-bolster-jsw-results ; https://en.saarstahl.com/saarstahl/company/saarstahl-group/

[T42] US DOE/NETL, STEP 10 MWe sCO2 pilot

- Read level: programme pages.
- Supports: GTI with SwRI and GE designing/building 10 MWe sCO2 pilot at SwRI San Antonio; award value $169,471,029; project window 2016-2026; targets: cycle efficiency pathway >50%, >700 C turbine inlet, 2-5 percentage point net plant efficiency improvement, 3-4% LCOE reduction; recompression closed Brayton cycle.
- Limitations: government programme goals, not demonstrated commercial results.
- https://netl.doe.gov/carbon-management/sco2/step10pilotplant ; https://www.netl.doe.gov/projects/project-information.aspx?p=FE0028979

[T43] Wikipedia, "Cornish engine" (fetched in full)

- Read level: full article.
- Supports: duty measure (foot-pounds per 94-lb bushel); early Watt duty ~20 million, later over 30 million; Trevithick high-pressure engines approaching 50 million duty; Cornish efficiency culture.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Cornish_engine

[T44] Wikipedia, "Corliss steam engine" (fetched in full)

- Read level: full article.
- Supports: George Henry Corliss of Providence; US patent 6,162 of 10 March 1849 (wrist-plate valve gear, trip valves); Centennial Engine 1876: 45 ft tall, 44-inch bore, 10-foot stroke, 30-

foot flywheel, 1,400 hp; started by Grant and Pedro II; mile-plus of shafting.

- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Corliss_steam_engine

[T45] Wikipedia, "Pearl Street Station" (fetched in full)

- Read level: full article.
- Supports: service began 4 September 1882; 255-257 Pearl Street; 50-by-100-foot site; Edison Illuminating Company; first commercial US central station; Jumbo dynamos engine-driven.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Pearl_Street_Station

[T46] Wikipedia, "Mercury vapour turbine" (fetched in full)

- Read level: full article.
- Supports: binary mercury-steam plants designed by William Le Roy Emmet, built by General Electric, operating 1923-1950 (e.g. Kearny, New Jersey, 20 MW mercury + 30 MW steam, from 1933; Schiller Station, Portsmouth NH; Hartford Electric Light 10 MW unit described in the 1937 Electrical Year Book at 34.8% efficiency); abandonment driven by capital cost, mercury toxicity, and metallurgical advances that let steam-only plants reach the same temperatures.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Mercury_vapour_turbine

[T47] Wikipedia, "Air preheater" and "Fredrik Ljungstrom" (fetched in full)

- Read level: full articles.
- Supports: Ljungstrom air preheater's attributed worldwide fuel savings (~4.96 billion tons of oil); the brothers' companies (Ljungstrom Steam Turbine Co.; STAL); association with Alfred Nobel; Fredrik's wider patent portfolio.
- Limitations: tertiary; the 4.96-billion-ton figure is an attribution carried by the article.
- https://en.wikipedia.org/wiki/Air_preheater ; https://en.wikipedia.org/wiki/Fredrik_Ljungstr%C3%B6m

[T48] Wikipedia, "SS Normandie" (fetched in full)

- Read level: full article.
- Supports: turbo-electric transmission; Alsthom of Belfort machinery; most powerful steam turbo-electric liner; 1935 trials, 32.1 knots.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/SS_Normandie

[T49] Wikipedia, "NS Savannah" (fetched in full)

- Read level: full article.
- Supports: first nuclear-powered merchant ship; launched 21 July 1959; cost $46.9M including $28.3M reactor and core; demonstration purpose; Lenin two years earlier as first nuclear civilian vessel.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/NS_Savannah

[T50] Wikipedia, "Queen Elizabeth 2" (fetched in full)

- Read level: full article.
- Supports: 1986/87 re-engining from steam turbines to diesel-electric; fuel-economy motive.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Queen_Elizabeth_2

[T51] Wikipedia, "Synchronous condenser" (fetched in full)

- Read level: full article.
- Supports: reactive power generation/absorption; voltage support; rotating inertia as a system benefit; deployment alongside inverter-based generation; retired machines reused.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Synchronous_condenser

[T52] Wikipedia, "Larderello" (fetched in full)

- Read level: full article.
- Supports: Prince Piero Ginori Conti's 4 July 1904 test lighting four bulbs at the Larderello dry-steam field; first geothermal power plant 1911.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Larderello

[T53] Wikipedia, "Ouarzazate Solar Power Station" (fetched in full)

- Read level: full article.
- Supports: Noor complex 510 MW; world's largest CSP complex; storage enabling generation after sunset.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Ouarzazate_Solar_Power_Station

[T54] Wikipedia, "Ivanpah Solar Power Facility" (fetched in full)

- Read level: full article.
- Supports: opened 2014; power-tower boilers feeding steam turbines; closure decision announced then reversed by CPUC.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Ivanpah_Solar_Power_Facility

[T55] API 611 / API 612 steam turbine standards

- Read level: official standard titles and scope statements located on API publishing channels (preview PDFs of "General-purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services" and "Petroleum, Petrochemical, and Natural Gas Industries - Steam Turbines - Special-purpose Applications"); full texts paywalled, not read.
- Supports: existence, numbering and general-purpose/special-purpose division of refinery steam-turbine standards.
- Limitations: scope statements only; no clause-level claims made in the book.
- https://api.stdlink.com/preview/2024/04/16/975e443163814e7080c0a0eb0f72cf24.pdf ; https://api.stdlink.com/preview/2024/07/20/9c9182c40ab94e47806617deb9bdfdf4.pdf

[T56] Wikipedia, "Bharat Heavy Electricals" (fetched in full)

- Read level: full article.
- Supports: founded 1956; Soviet technical assistance; Heavy Electricals (India) Ltd merged 1974; research institutes at Tiruchirappalli, Bangalore, Bhopal, Haridwar; patenting activity.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Bharat_Heavy_Electricals

[T57] Wikipedia, "Ansaldo Energia" and "Skoda Works" (fetched in full)

- Read level: full articles.
- Supports: Ansaldo's 1853 origins and 2013 sale arrangements (EUR 1.07 billion for 100%); Skoda's nuclear work from 1956, A1 components from 1964.
- Limitations: tertiary.
- https://en.wikipedia.org/wiki/Ansaldo_Energia ; https://en.wikipedia.org/wiki/%C5%A0koda_Works

[T58] Wikipedia, "Rolls-Royce SMR" (fetched in full)

- Read level: full article.
- Supports: 470 MWe design; 2019 estimate ~GBP1.8bn per unit in production; GDA began April 2022; Wylfa selected for up to three units; Temelin early-works contract April 2026; "power a city the size of Sheffield".
- Limitations: tertiary; programme figures are estimates and evolve.
- https://en.wikipedia.org/wiki/Rolls-Royce_SMR

[T59] Reuters (21 July 2025), "Rush for US gas plants drives up costs, lead times"; S&P Global (20 May 2025), gas turbine waits up to seven years

- Read level: search excerpts.
- Supports: 2025 power-equipment cost and lead-time surge; up-to-seven-year waits for large machines.
- Limitations: gas-turbine-centric; used in the book as the shared-supply-chain signal, explicitly framed as such.
- https://www.reuters.com/business/energy/rush-us-gas-plants-drives-up-costs-lead-times-2025-07-21/ ; https://www.spglobal.com/energy/en/news-research/latest-news/electric-power/052025-us-gas-fired-turbine-wait-times-as-much-as-seven-years-costs-up-sharply

[T60] Bloomberg (March/April 2025), GE Vernova backlog reporting

- Read level: search excerpts.
- Supports: equipment order backlog stretching into 2028.
- Limitations: excerpt-level.
- https://www.bloomberg.com/news/articles/2025-03-11/ge-vernova-ceo-sees-order-backlog-stretching-into-2028

[T61] Wikipedia, "NuScale Power" (fetched in full)

- Read level: full article.
- Supports: 77 MWe module design; US regulatory certification status.

- Limitations: tertiary; programme status volatile (project cancellations on record).
- https://en.wikipedia.org/wiki/NuScale_Power

[T62] Wikipedia, "Auguste Rateau" (fetched in full)

- Read level: full article.
- Supports: Rateau's biography and career; 1896 multi-stage impulse turbine patent; torpedo-boat installation shown at the 1900 Paris Exposition; founding of the Societe Rateau (1903, ~3,000 workers); centrifugal compressor work including the 1906 Armengaud-Lemale gas turbine; post-WWI aviation turbocharging; ASME honorary membership (1919).
- Limitations: tertiary; company workforce figure is approximate as printed.
- https://en.wikipedia.org/wiki/Auguste_Rateau

[T63] Wikipedia, "Steam turbine locomotive" (fetched in full)

- Read level: full article.
- Supports: Ljungstrom's 1921 turbine locomotive; the 1925 NOHAB condensing locomotive in Argentina and its low water loss; the 1928 Krupp-Zoelly condensing design; the LMS Turbomotive of 1935 (six-nozzle admission, comparative efficiency, 1952 conversion after turbine failure); SNCF 232.Q.1 of 1940.
- Limitations: tertiary; individual locomotive histories are summarised from specialist literature cited there.
- https://en.wikipedia.org/wiki/Steam_turbine_locomotive

[T64] Wikipedia, "Northeast blackout of 2003" (fetched in full)

- Read level: full article.
- Supports: timeline detail (final cascade ~4:10pm EDT, Ohio line-tree contacts); the FirstEnergy alarm-software failure narrative; New York City's full restoration by 16 August.
- Limitations: tertiary. Its aggregate figures (55 million people; "second most widespread" world ranking) are NOT used in the book - scope and characterisation follow the owner report [T65] instead (estimated 50 million; "one of the largest blackouts in the history of North America").
- https://en.wikipedia.org/wiki/Northeast_blackout_of_2003

[T65] US-Canada Power System Outage Task Force, "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations" (April 2004, full PDF fetched from energy.gov)

- Read level: primary owner report; introduction, outage-description and investigation-process sections read in the full document.
- Supports: estimated 50 million people affected and 61,800 MW of load lost across Ohio, Michigan, Pennsylvania, New York, Vermont, Massachusetts, Connecticut, New Jersey and Ontario; onset a few minutes after 16:00 EDT; the report's own characterisation as "one of the largest blackouts in the history of North America"; uneven restoration (up to 4 days in some US areas, rolling blackouts over a week in parts of Ontario); the FirstEnergy EMS alarm-system failure findings; the 1965 Northeast comparison (30 million people, over 20,000 MW).

- Limitations: official scope estimate is deliberately approximate ("an estimated 50 million"); later secondary sources sometimes print higher figures.
- https://www.energy.gov/sites/default/files/oeprod/DocumentsandMedia/BlackoutFinal-Web.pdf

Verification and read-honesty note

Every figure in the book that carries a citation tag was checked against the source listed here during writing. Sources marked "search excerpts" were read as returned excerpts, not full documents; that read level is stated per entry. Forecasts and market projections are labelled in the book's text. Where a claim rests on general engineering knowledge rather than a fetched source, its entry above says so explicitly ([T22], [T23], [T24]). [T20], [T41], [T46] and [T55] were strengthened to fetched sources in the November 2 verification pass.