THE AIR CONDITIONER: SOURCE COMPANION

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companion to THE AIR CONDITIONER: Ice, Vapor, Empire

Every reference number [n] in the manuscript resolves here. Each entry records what the source is, how fully it was read, what it supports, and its limitations. Read levels: FULL (read end to end), EXCERPT (the cited passages read directly), HIGHLIGHTS (search-result extracts from the owning site). Sources read for background but not cited are listed separately at the end. Leads registered but never read are excluded entirely.

Numbered sources

[1] Encyclopaedia Iranica: Badgir (windcatcher) | undated | HIGHLIGHTS | Windcatcher (badgir) function and typology; the Dowlat Abad garden windcatcher in Yazd at 33.35 m, among the tallest surviving | Encyclopaedia reference; the Dowlatabad windcatcher height is 33.35 m here, 33.8 m in other references Source: https://iranicaonline.org/articles/badgir

[2] Research-repository study of Yazd's passive cooling (qanat, windcatcher, ice houses) | undated | HIGHLIGHTS | Yazd as the canonical desert-cooling city; qanat-fed evaporative cooling, yakhdan ice houses, windcatcher performance claims | Single institutional repository paper; used for qualitative claims only Source: https://doi.org/10.24384/0m49-rr97 (corroborated by Energy Procedia 2015, https://doi.org/10.1016/j.egypro.2015.11.292)

[3] Sherwood & Huber, "An adaptability limit to climate change due to heat stress", PNAS 107(21) | 2010 | EXCERPT | Wet-bulb 35 ℃ as the physiological survivability ceiling for healthy humans; peak wet-bulb today never

exceeds about 31 ℃; extended exceedance of 35 ℃ induces hyperthermia | Modeling paper; the 35 ℃ threshold is a physiological limit, not a forecast Source: https://www.pnas.org/doi/full/10.1073/pnas.0913352107

[4] Wikipedia: Frederic Tudor | read 2026-11-01 | EXCERPT | 1806 brig Favorite, Rockwood/Saugus to Martinique, ~1,500 miles; Boston Gazette "No joke… slippery speculation" quote, sailing February 10; ~$4,500 first-voyage loss; Tudor Ice Company's Caribbean, Southern, European, India and Hong Kong routes; debtors' prison episodes | Tertiary compilation; Gazette quote verified in situ Source: https://en.wikipedia.org/wiki/Frederic_Tudor

[5] Telegraph (India): the Tuscany and the first Calcutta ice shipment | undated | HIGHLIGHTS | The Tuscany arrived Calcutta September 1833 with ~180 tonnes of Boston ice; over a third melted on passage; "ice grew on trees" reception anecdote | Newspaper retelling of the 1833 shipment; figures as published Source: https://www.telegraphindia.com/my-kolkata/news/yesterdate-this-day-from-kolkatas-past-september-6-1833/cid/1964103

[6] Smithsonian American History: ice harvesting and the icebox era | undated | HIGHLIGHTS | Harvest practice: blocks cut once ice reached roughly eight inches; the household icebox lasting into the 1930s | Museum public-history pages Source: https://americanhistory.si.edu/explore/stories/keeping-your-food-cool-ice-harvesting-electric-refrigeration

[7] ASHRAE Terminology: ton of refrigeration | undated | HIGHLIGHTS | One ton of refrigeration = 12,000 Btu/h (about 3.52 kW), the melt rate of one short ton of ice in 24 hours | Definitions database Source: https://terminology.ashrae.org/?entry=ton+of+refrigeration

[8] Wikipedia: William Cullen | read 2026-11-01 | EXCERPT | Cullen at Glasgow (and later Edinburgh); the ether-under-vacuum demonstration producing ice; account in the Edinburgh Physical and Literary Essays 1748; 1756 public demonstration as the first documented artificial refrigeration | Tertiary; dates 1748/1756 follow the standard historical record Source: https://en.wikipedia.org/wiki/William_Cullen

[9] Founders Online: Benjamin Franklin's 1758 letter on evaporative cooling | 1758 | HIGHLIGHTS | Franklin's ether-evaporation experiment letter (cooling a thermometer below the air's temperature, the wet finger in wind observation) | Primary letter hosted by the National Archives Source: https://founders.archives.gov/documents/Franklin/01-06-02-0139

[10] ASME landmark: Perkins' vapor-compression machine | undated | HIGHLIGHTS | Jacob Perkins' 1834 closed-cycle vapor-compression patent (ether); Oliver Evans' 1805 vapor-compression concept; Alexander Twining's later work; the 1835 Hague-built machine | Engineering-society landmark record Source: https://www.asme.org/about-asme/engineering-history/landmarks/274-perkins-vapor-compression-cycle-for-refrigeration

[11] US patent 8,080, John Gorrie, granted May 6, 1851 | 1851 | EXCERPT | "Improved machine for the artificial production of ice and for general refrigeratory purposes"; compression-air cycle described in the first person; patent dates and grant status | Primary patent document Source: https://patents.google.com/patent/US8080A

[12] Australian Dictionary of Biography: James Harrison | read 2026-11-01 | EXCERPT | Geelong; first Australian manufactured ice at Rocky Point, local patent 1854; Bendigo brewers Glasgow & Co.; London patents 1856 (747) and 1857 (2362); talks with Faraday and Tyndall; Sydney Ice Co.; later revolutionary refrigerator patents | Scholarly national dictionary; the strongest source in this chapter Source: https://adb.anu.edu.au/biography/harrison-james-2165

[13] The Spectator archive, 25 October 1873 | 1873 | HIGHLIGHTS | The 1873 frozen-meat-to-England attempt associated with Harrison's circle, the meat spoiling; contemporary press register of the failure | Single contemporary notice; used for the failure, not the meat trade's later success Source: https://archive.spectator.co.uk/article/25th-october-1873/2/we-regret-to-observe-that-the-project-of-bringing-

[14] Nature 149, 630: Carl von Linde's ammonia compression machine | 1876 (historical note) | HIGHLIGHTS | Linde's 1876 improved ammonia

vapor-compression refrigerator; the industrialization point for mechanical refrigeration | Historical note; used for the 1876 date and significance Source: https://doi.org/10.1038/149630a0

[15] Wikipedia: Ferdinand Carré | read 2026-11-01 | EXCERPT | First absorption refrigerator (water/sulphuric acid, then ammonia/water); French patent 1859; the 1862 London exhibition machine; the Harrison-derived elements | Tertiary; patent years vary across sources, so the manuscript avoids the contested year Source: https://en.wikipedia.org/wiki/Ferdinand_Carr%C3%A9

[16] US Department of Energy: History of Air Conditioning | undated | EXCERPT | Gorrie's 1851 patent and failed commercialization; Carrier's 1902 Buffalo Forge task; the 1904 St. Louis fair; the 1922 Metropolitan Theater; Frigidaire's 1929 split room cooler; Schultz & Sherman's 1932 window unit patent; GE's 32 prototypes; Galson's 1947 figure of 43,000 units sold; 87% of US households with air conditioning (EIA) | Government public-history article; the load-bearing spine of chapters 4, 8 and 9 Source: https://www.energy.gov/articles/history-air-conditioning

[17] Carrier: the invention of air conditioning (July 17, 1902) | undated | HIGHLIGHTS | The July 17, 1902 date for Carrier's drawings for the Sackett & Wilhelms lithographing plant; the humidity-control origin story | Company history; the founding date is the company's own record Source: https://www.williscarrier.com/weathermakers/1876-1902/ (and https://carrier.com/us/en/history/invention-of-air-conditioning)

[18] NC State Textiles history: Stuart W. Cramer | undated | EXCERPT | Cramer coined "air conditioning" in an address to the May 1906 meeting of the American Cotton Manufacturers; his humidity-control work in textile mills | University-hosted trade history Source: https://history.textiles.ncsu.edu/textile-people/stuart-w-cramer/

[19] Willis Carrier documentary: Weathermakers 1915-1922 | read 2026-11-01 | EXCERPT | Carrier Engineering Corporation founded July 1, 1915 on $32,600 scraped together by seven young engineers; first contract

booked 18 days later; the early industrial client list across 200 industries | Documentary site drawing on the Carrier archive Source: https://www.williscarrier.com/weathermakers/1915-1922/

[20] Willis Carrier documentary: Weathermakers 1923-1929 | read 2026-11-01 | EXCERPT | The centrifugal chiller as Carrier's most influential innovation; J.L. Hudson department store installation (Detroit); "people fainted" on basement bargain days; the Rivoli Theatre installation; the movie-palace beachhead | Documentary site drawing on the Carrier archive Source: https://www.williscarrier.com/weathermakers/1923-1929/

[21] Mike Pauken, "Sleeping Soundly on Summer Nights: A History of Air Conditioning in the Home", ASHRAE Journal | undated (centennial series) | EXCERPT | GE hermetically sealed motor-compressor 1924; water-cooled condensers requiring plumbing and sewer hookups; 30-ampere residential service and the 50% branch-circuit motor limit; Chicago central-business-district capacity 5,200 tons (1932) to 28,000 tons (1948); condensers' potential water demand vs. the city's 75 MGD peak supply | ASHRAE historical paper; figures as published Source: https://www.ashrae.org/file%20library/about/mission%20and%20vision/ashrae%20and%20industry%20history/sleeping-soundly-on-summer-nights-a-history-of-air-conditioning-in-the-home.pdf

[22] US EPA SNAP: refrigerant safety history | undated | EXCERPT | Midgley's 1926-1930 search; toxicity of the early working fluids; the three-day identification and synthesis of the new compound; the guinea-pig toxicity test; the Fréon family (R-12, R-11, R-114, R-113, R-22) and their dates; 1963: 98% of US refrigerators and 372 million pounds annual production | Regulator's technical history; the refrigerant chemistry spine of chapter 7 Source: https://www.epa.gov/snap/refrigerant-safety

[23] Architect of the Capitol: Keeping Congress Cool for the Summer | undated | EXCERPT | Nineteenth-century Capitol ventilation campaigns; the air-conditioning of the House and Senate chambers, work completed by August 1929; the 1935 extensions | Official congressional history office

Source: https://www.aoc.gov/explore-capitol-campus/blog/keeping-congress-cool-summer

[24] US House of Representatives history blog: "Vent-Elation" | 2014 | HIGHLIGHTS | The 1928 chamber-cooling episode and Garner's quip on the air-conditioned House; Carrier's Capitol installation | Official House history office blog Source: https://history.house.gov/Blog/2014/July/7-08-Vent-Elation/

[25] ASME landmark: Milam high-rise air-conditioned building | undated | HIGHLIGHTS | The Milam Building, San Antonio, 1928: the first air-conditioned high-rise office building in the United States; ~300 tons of capacity | Engineering-society landmark record Source: https://www.asme.org/about-asme/engineering-history/landmarks/155-milam-high-rise-air-conditioned-building

[26] Infoplease / US Census Bureau Profile America: automobile air conditioning | undated | HIGHLIGHTS | The 1939 Packard as the first factory-installed automobile heating/air-conditioning system, shown at the 40th Automobile Show in Chicago | Two converging references (almanac + Census Bureau feature) Source: https://www.infoplease.com/askeds/automobile-air-conditioning; https://www.prnewswire.com/news-releases/us-census-bureau-daily-feature-for-november-29-300001265.html

[27] Toshiba air-conditioning company history | undated | HIGHLIGHTS | 1930 Japan's first hermetic refrigerator compressor; 1953 RAC-101 room cooler; 1961 world-first home split-type room air conditioner (CLU-7I); 1967 rotary compressor | Official company history; highlights read in the Japanese original of the R&D history page and the English corporate history page Source: https://www.toshiba-carrier.co.jp/global/about/history.htm; https://www.toshiba-lifestyle.com/jp/corporate/rd/research/history/airconditioner/

[28] METI/ANRE: Japan's Top Runner efficiency program | undated | HIGHLIGHTS | Top Runner method: the best product on the market sets the mandatory standard for a future year; applied to room air conditioners

among the first product classes | Agency program documentation Source: https://www.enecho.meti.go.jp/category/saving_and_new/saving/enterprise/equipment/toprunner/en/02_aircon.html

[29] Japanese Ministry of the Environment: Cool Biz launch press release | 2005-04-27 | EXCERPT | Cool Biz summer campaign setting office air-conditioning thermostats to 28 ℃; naming announcement April 25, 2005; Expo Dome "COOL BIZ Collection" | Official release Source: https://www.env.go.jp/en/press/2005/0427a.html

[30] Daikin: R-32 patent non-assert pledge | 2019-07-01 | EXCERPT | Free access to pledged patents for equipment using HFC-32 (R-32), non-blended single-component refrigerant; Daikin's first HFC-32 residential equipment in Japan, 2012; earlier 93-patent free-access offer for emerging countries (2011), then expanded | Company press release; the R-32 transition spine Source: https://www.daikin.com/press/2019/190701

[31] NREL for US DOE: Mapping the Supply Chain for Room Air Conditioning Compressors | 2019-05 | FULL | GMCC roughly a quarter of world rotary compressor capacity; four firms over 60%; China producing 167 million units (2017), ~42% variable-speed; refrigerant GWP figures (R-22 1810, R-410A 2088, R-32 675, R-290 3.3); Toshiba's late-1980s inverter commercialization | Technical report; the compressor-belt spine of chapters 11, 12 and 24 Source: https://www.osti.gov/biblio/1524770 (https://doi.org/10.2172/1524770)

[32] JRAIA: World Air Conditioner Demand estimates | 2025 edition | EXCERPT | World demand 2024 estimated at 131,638 thousand units, 106% of the prior year; China 49,726k (~38%); Asia ex-Japan/China 25,249k; North America 19,199k; Japan 10,187k; Europe 9,533k; Latin America 7,325k | Industry-association statistical series; values rounded per the publication Source: https://www.jraia.or.jp/english/statistics/file/2508SH_World_AC_Demand_2025_e.pdf

[33] Trane Technologies: Q4 and full-year 2024 results | 2025-01-30 | HIGHLIGHTS | 2024 revenue ~$19.8 billion, up 12%; bookings and backlog

commentary; data-center and decarbonization demand | Company results release; figures as reported Source: https://investors.tranetechnologies.com/news-and-events/news-releases/news-release-details/2025/Trane-Technologies-Reports-Strong-Fourth-Quarter-and-Full-Year-2024-Results-Robust-Bookings-and-Backlog-Provide-Strong-Visibility-Entering-2025/default.aspx

[34] Carrier Global: 2024 results and 2025 outlook | 2025-02 | HIGHLIGHTS | 2024 sales $22.5 billion; portfolio moves (divestitures) noted; segment structure | Company results release Source: https://www.corporate.carrier.com/news/news-articles/202502_carrier-reports-strong-2024-results-announces-2025-outlook.html

[35] Daikin Industries: financial data, fiscal year ended March 2025 | 2025 | HIGHLIGHTS | Net sales 4,752,335 million yen (FY ended March 2025), up from 4,395,316 million; air conditioning and chemicals as the core | Company financial data page Source: https://www.daikin.com/investor/financial

[36] Midea Group: record 2024 annual results | 2025 | HIGHLIGHTS | Revenue RMB 409.1 billion, up 9.5%; net profit attributable RMB 38.5 billion, up 14.3%; operating cash flow RMB 60.5 billion | Company announcement Source: https://www.midea.com.cn/en/about-midea/news/midea-group-reports-record-2024-results–delivers-unprecedented-

[37] Gree Electric Appliances: 2024 Annual Report (English) | 2025 | HIGHLIGHTS | 2024 revenue CNY 190.038 billion; net profit CNY 32.185 billion | Official annual report PDF located; figures from the reported highlights Source: https://global.gree.com/upload/files/2026/6/Annual_Report_2024_%EF%BC%88English_Version%EF%BC%89.pdf

[38] Mitsubishi Electric: FY2025 consolidated results (April 2024-March 2025) | 2025-04-28 | HIGHLIGHTS | Revenue 5,521.7 billion yen for fiscal 2025 | Company results PDF; figure as reported Source: https://www.mitsubishielectric.com/en/pr/2025/pdf/0428-a1.pdf

[39] LG Electronics: Q4 and full-year 2024 results | 2025-01-23 | EXCERPT | Consolidated 2024 revenue KRW 87.73 trillion (record); operating profit KRW 3.42 trillion; Home Appliance & Air Solution revenue KRW 33.2 trillion | Company newsroom release Source: https://www.lg.com/global/newsroom/news/corporate/lg-announces-fourth-quarter-and-full-year-2024-financial-results/

[40] Euromonitor International: Air Conditioners in India | 2025 edition | EXCERPT | Voltas leads with 19% retail volume share 2025; LG 17%; Daikin 13%; top three near half of retail volume | Paywalled market research; the public abstract was read, full tables not Source: https://www.euromonitor.com/air-conditioners-in-india

[41] Livemint: Voltas vs Blue Star after Q4 FY25 results | 2025 | HIGHLIGHTS | Blue Star Q4FY25 revenue up 21% YoY to 4,020 crore rupees; FY25 consolidated EBITDA 876 crore rupees, up 32% | Financial press; figures as reported Source: https://www.livemint.com/market/stock-market-news/voltas-vs-blue-star-which-ac-stock-looks-stronger-after-q4-results-11747035650771.html

[42] Bureau of Energy Efficiency, India: star labeling program | undated | HIGHLIGHTS | The BEE star label for room air conditioners, launched May 2006; the label ladder as India's efficiency signal | Regulator's program pages; the 2006 start date is the program's own record Source: https://beeindia.gov.in/show_content.php?lang=1&level=1&lid=322&ls_id=198

[43] Ozone Cell, MoEFCC: India Cooling Action Plan (ICAP) | March 2019 | HIGHLIGHTS | India's twenty-year cooling plan, 2017-18 to 2037-38: cooling-demand reduction targets, refrigerant transition, cold-chain and servicing-sector goals | Official plan PDF located and opened; targets as published Source: https://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf (landing: https://ozonecell.nic.in/home-page/resource-informations/reports-publications/india-cooling-action-plan/)

[44] UNEP: Sustainable food cold chains press release and report | 2022-11-12 | HIGHLIGHTS | 526 million tonnes of food production lost annually, ~12%, for want of refrigeration; food cold chains ~4% of global GHG emissions including loss and waste; 144 million tonnes saveable with proper cold chains | Agency release on the joint UNEP-FAO report Source: https://www.unep.org/resources/report/sustainable-food-cold-chains

[45] Congressional Research Service: Data Centers and Their Energy Consumption (R48646) | 2024 | EXCERPT | Computing power and servers ~40% of data-center electricity; cooling another 38-40%; a 100 MW data center can use ~2 million liters of water per day | CRS explainer; ranges as published Source: https://www.congress.gov/crs-product/R48646

[46] IEA-4E: data-centre cooling energy review | undated | HIGHLIGHTS | Cooling's share of data-center energy and the efficiency technology survey underpinning chapter 17-18's treatment | Technology collaboration program review Source: https://www.iea-4e.org/edna/publications/liquid-cooling-in-data-centres/

[47] Kingma & van Marken Lichtenbelt: "Energy consumption in buildings and female thermal demand", Nature Climate Change | 2015 | EXCERPT | Standard office thermal models derive from a 1960s male-metabolic model and may overestimate female metabolic rate by up to 35%; the thermostat-gap argument of chapter 20 | Peer-reviewed; the 35% figure is a model result, not a field census Source: https://www.nature.com/articles/nclimate2741

[48] de Dear & Brager: developing the adaptive model of thermal comfort (ASHRAE RP-884) | 1998 | EXCERPT | The adaptive comfort model from a global field-study database; occupants of naturally ventilated buildings accept and prefer wider temperature bands | Scholarly archive of the published paper Source: https://escholarship.org/uc/item/4qq2p9c6

[49] ILO: Working on a Warmer Planet | 2019-07-01 | HIGHLIGHTS | Heat stress projected to cut total working hours 2.2% by 2030 (80 million full-time-equivalent jobs), at US$2,400 billion; in-sun assumption raises this to

3.8% (136 million FTE); Southern Asia and Western Africa worst hit (~5%); losses US$280 billion in 1995 | Official ILO report PDF; a projection, labeled as such in the manuscript Source: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_711919.pdf

[50] Molina & Rowland: "Stratospheric sink for chlorofluoromethanes", Nature 249, 810-812 | 1974 | EXCERPT | The CFC-ozone hypothesis: stratospheric photodissociation of chlorofluoromethanes catalyses ozone destruction | The primary paper; abstract read Source: https://www.nature.com/articles/249810a0

[51] UNEP Ozone Secretariat: Montreal Protocol results | undated | HIGHLIGHTS | ~99% of ozone-depleting substances phased out, about 1.8 million ODP tonnes; 198 parties, the universal-ratification treaty | Treaty secretariat figures Source: https://ozone.unep.org/facts-and-figures-ozone-protection

[52] Ozone Secretariat: Kigali Amendment ratification status | updated 2024 | EXCERPT | Kigali ratifications standing at 163 parties at reading; the secretariat's continuing ratification drive | Live count; the manuscript phrases it as "more than 160" Source: https://ozone.unep.org/kigali-amendment-ratifications-update

[53] UNEP: Kigali Amendment climate benefit | undated | HIGHLIGHTS | Full HFC phase-down avoids up to 0.4 ℃ of warming this century; >80% HFC reduction schedule | Agency assessment Source: https://ozone.unep.org/kigali-amendment-implementation-begins

[54] IEA: The Future of Cooling | 2018 | HIGHLIGHTS | Air conditioning ~10% of world electricity use; stock 1.6 billion units (2016) heading to 5.6 billion by 2050; annual sales 135 million units (2016); cooling electricity tripling past 2,000 TWh; units sold in Japan and the EU typically 25% more efficient than in the US and China; standards could halve the energy growth | IEA's flagship cooling report; the agency page renders limited text to

automated readers, figures taken from the report's published extracts and IEA highlights Source: https://www.iea.org/reports/the-future-of-cooling

[55] Sustainable Energy for All: Chilling Prospects special edition on heat vulnerability and mortality, with its global heat-mortality data story | 2025 | HIGHLIGHTS | Heat-related deaths estimated at 546,000 per year (2012-2021 average, Lancet Countdown figures reported by SEforALL), up 63% since the 1990s; over a billion people at risk from heat stress; ~60% of Africa's population without early-warning coverage; the access-to-cooling deficit framing of chapters 23 and 24 | Agency special edition; mortality figures are modeled estimates attributed to the Lancet Countdown Source: https://www.seforall.org/chilling-prospects-special-edition-data-story/global-heat-mortality-data

The 2024 Global Cooling Pledge Progress Report (coolcoalition.org) informed the treatment of the pledge in chapter 21 without supplying a cited figure.

Read for background but not cited

The Industries of India site and library (industriesofindia.com), including the published companion format this volume follows. ASHRAE's "Sleeping Soundly on Summer Nights" [21] additionally informed chapter 9's infrastructure account. General reference reading on refrigeration history (encyclopedia entries for Oliver Evans, Jacob Perkins, Alexander Twining and Carl von Linde) shaped chapters 3 and 5 without supplying specific cited claims.

A note on levels

Where a claim rests on HIGHLIGHTS, the exact figure as published by the owning source is quoted in the manuscript at the marker. Where a source disagrees with another (patent years, shipment tonnages, sales figures), the

manuscript says so or chooses the primary source. Forecasts are labeled forecasts in the text at the point of use.