T H E H Y D R O E L E C T R I C D A M

Source Companion

Ketineni Ramarao

A note on read levels. Every entry is marked by how far it was actually read: full (the whole page or document), excerpt (substantial portions), abstract (abstract and summary only), or search-result (title, snippet and metadata only). The “supports” line says exactly what in this book the source grounds; the “limitations” line says what it does not. Where sources conflict, the conflict is flagged in the entries rather than smoothed over.

Sources cited in this book

C1 - Types of Hydropower Plants

Read level: full. Supports: three plant types (impoundment/diversion/pumped storage); US 90,000+ dams <3% produce power; DOE size classes (large >30MW, small 100kW-10MW, micro <100kW). Limitations: US-focused; DOE definitions vary elsewhere. https://www.energy.gov/cmei/water/types-hydropower-plants

C2 - History of Hydropower

Read level: full. Supports: Greeks water wheels 2000+ yrs; Archimedes screw; Belidor 18th c; 1880 Grand Rapids dynamo; Redlands 1893 AC; Reclamation 1902; USACE 1920s; Rocky River pumped storage 1929; TVA 1933; FPC 1935; Hoover 1936; BPA 1937; 1940 hydro 40% of US generation; Fort Peck 10,500 workers; NEPA/Wild&Scenic/Fish&Wildlife acts 1968-74; Bath County 1985/2005/2009/2024 3GW; 2013 small hydro acts; Hydropower Vision 2016; HydroWIRES 2019. Limitations: US-centric official history. https://www.energy.gov/cmei/water/history-hydropower

C2b - Hydropower Vision (US DOE, 2016)

Read level: search-result. Supports: DOE Hydropower Vision (2016): most US potential in powering non-powered dams and upgrading existing fleet. Limitations: DOE report - US scope. https://www.energy.gov/cmei/water/history-hydropower

C3 - A brief history of hydropower

Read level: full. Supports: Han dynasty trip hammers; Arkwright Cromford 1771; Fourneyron 1827 6hp reaction turbine; Francis 1849; Pelton 1870s patent 1880; Kaplan 1913; Cragside 1878 first hydroelectric light; 1882 Wisconsin first multi-customer plant; Grand Rapids 1880, Ottawa 1881, Dolgeville 1881, Niagara Falls 1881; Germany first three-phase hydro system 1891; Australia first public southern hemisphere plant 1895; Adams Plant Niagara 1895 largest; Taipei Xindian 1905 500kW; New Deal; 1940s-70s state utility buildout; Brazil/China late 20th c leadership. Limitations: trade-body framing. https://www.hydropower.org/iha/discover-history-of-hydropower

C4 - Types of Hydropower Turbines

Read level: full. Supports: Kaplan adjustable blades+wicket gates 1919 date attribution; Francis most common; impulse vs reaction distinction. Limitations: DOE dates Kaplan’s turbine to 1919; IHA dates his patent to 1913. https://www.energy.gov/cmei/water/types-hydropower-turbines

C5 - Hoover Dam: Frequently Asked Questions

Read level: full. Supports: Hoover: 726.4 ft; 6.6M tons; arch-gravity; 45,000 psf base pressure; 3.25M cu yd concrete in dam (4.36M with works); first concrete Jun 6 1933, last May 29 1935; 582 miles cooling pipe, 1000 tons ice/day, cooling done Mar 1935; 215 blocks; 21,000 men total, 3,500 avg, 5,218 peak Jun 1934; Boulder City; 22.7mi railroad; 222mi transmission line for construction power; andesite breccia foundation; four 50-foot diversion tunnels. Limitations: official operator page. https://www.usbr.gov/lc/hooverdam/faqs/damfaqs.html

C6 - Pumped storage hydropower explained (IHA factsheet)

Read level: full. Supports: PSH as water battery; stores surplus, releases at demand; IHA framing. Limitations: advocacy body. https://www.hydropower.org/factsheets/pumped-storage

C7b - Facts about Hydropower (IHA)

Read level: search-result. Supports: IHA facts: “No country has come close to achieving 100% renewables without hydropower in the energy mix”. Limitations: industry body - attributed claim. https://www.hydropower.org/iha/discover-facts-about-hydropower

C8 - 2025 World Hydropower Outlook (IHA)

Read level: full (PDF). Supports: IHA 2025 Outlook: 4,578 TWh generated 2024 (+~10% from 4,180 TWh 2023); 1,443 GW total incl PSH (+24.6 GW 2024); conventional 1,254 GW +16.2 GW; PSH 189 GW +8.4 GW (+5%); PSH >90% of world energy storage; COP29 pledge 1,500 GW storage by 2030 (58 countries); pipeline ~1,075 GW (600 PSH/475 conventional); China +14.4 GW 2024 incl 7.75 PSH, 91 GW PSH under construction, 120 GW 2030 target, 136 GW more moving; Africa +4.1 GW conventional 2024, hydro ~20% of Africa generation, ~10% of technical potential harnessed (mostly unharnessed); Europe 680 TWh decade-high; South America ~45% electricity from hydro, ~30% potential used; India 132 projects; PSH annual additions

nearly doubled in two years; PSH pipeline ~600 GW, nearly triple the previous (2023) pipeline survey; 2024 regional additions: South America 306 MW, North and Central America 541 MW. Limitations: industry body; conventional vs IRENA figure basis differs (1,254 vs 1,283) - flag. https://www.hydropower.org/publications/2025-world-hydropower-outlook (PDF mirror large.stanford.edu/courses/2025/ph240/contreras2/docs/iha-2025.pdf)

C10 - Renewable Power Generation Costs in 2024 (IRENA)

Read level: search-result. Supports: IRENA costs 2024: 91% of new utility-scale renewables cheaper than fossil; LCOE trends. Limitations: press/summary level. https://www.irena.org/-/media/files/irena/agency/publication/2025/jul/irena_tec_rpgc_in_2024_2025.pdf

C11 - Dam Failure Case Study: Banqiao Dam (ASDSO)

Read level: search-result. Supports: Banqiao: Typhoon Nina landfall; collision with cold front; 3-day rain. Limitations: official US dam-safety body. https://damsafety.org/reference/dam-failure-case-study-banqiao-dam-china-1975

C12b - Dam Failures and Lessons Learned (ASDSO)

Read level: search-result. Supports: Malpasset 1959: arch dam failure, abutment fissure, 421 killed (ASDSO lessons-learned table). Limitations: dam-safety body. https://damfailures.org/lessons-learned/timely-warning-and-rapid-public-response-are-critical

C14 - The Vajont landslide (Protezione Civile)

Read level: search-result. Supports: Vajont: dam >260m high; Friuli-Venezia Giulia/Veneto border. Limitations: Italian civil protection. https://servizio-nazionale.protezionecivile.gov.it/en/pagina-base/vajont-landslide/

C15 - Dams and Development: The Report of the World Commission on Dams

Read level: excerpt. Supports: WCD final report Nov 2000: Dams and Development framework. Limitations: excerpt-level. https://www.internationalrivers.org/wp-content/uploads/sites/86/2022/06/world_commission_on_dams_final_report.pdf

C16 - The World Bank’s Big Dam Legacy (International Rivers)

Read level: full. Supports: World Bank funded 550+ dams, $90B+ (2007 dollars) loans/guarantees; funding declined in 1990s. Limitations: advocacy source - attribute. https://www.internationalrivers.org/wp-content/uploads/sites/86/2020/05/the_world_banks_big_dam_legacy.pdf

C17 - Greenhouse Gas Emissions from Reservoir Water Surfaces (Deemer et al., 2016)

Read level: abstract. Supports: Deemer et al 2016 BioScience: reservoirs important GHG source; global synthesis. Limitations: abstract-level. https://pmc.ncbi.nlm.nih.gov/articles/PMC7425809/

C18 - Hundreds of new dams could mean trouble for our climate (Science)

Read level: search-result. Supports: reservoirs ~1.3% of human-caused GHG emissions per Deemer et al 2016; ~Canada-scale. Limitations: news coverage of study - attribute. https://www.science.org/content/article/hundreds-new-dams-could-mean-trouble-our-climate

C19 - Klamath River dams fully removed ahead of schedule (Office of the Governor, California)

Read level: search-result. Supports: Klamath: four dams fully removed, ahead of schedule, announced Oct 2 2024; largest river restoration project (CA gov claim). Limitations: government press. https://www.gov.ca.gov/2024/10/02/klamath-river-dams-fully-removed-ahead-of-schedule/

C21 - Final Step in Klamath River Dam Removal Opens Path for Returning Salmon (NOAA Fisheries)

Read level: search-result. Supports: Klamath removal reopened ~400 miles salmon habitat. Limitations: federal agency. https://www.fisheries.noaa.gov/feature-story/final-step-klamath-river-dam-removal-opens-path-returning-salmon

C23 - Backgrounder: China’s Three Gorges project (People’s Daily)

Read level: full. Supports: Three Gorges: 2,309 m long, 185 m high dam; five-tier ship lock; 32 generators. Limitations: state media. http://en.people.cn/n3/2016/0918/c90000-9116238.html

C24 - Three Gorges ’immigrants’ face ongoing relocation and dwindling prospects (Reuters via Probe International)

Read level: search-result. Supports: Three Gorges: 1.3M relocated over 17 years; $59B cost (Reuters via Probe). Limitations: advocacy republication of Reuters - attribute. https://journal.probeinternational.org/2012/08/24/three-gorges-immigrants-face-ongoing-relocation-and-dwindling-prospects/

C26 - Perguntas Frequentes (Itaipu Binacional)

Read level: search-result. Supports: Itaipu: 20 units, 14 GW, ~8.6% of Brazil consumption. Limitations: operator page. https://www.itaipu.gov.br/contatos/perguntas-frequentes

C27 - Treaty of Itaipu (1973)

Read level: search-result. Supports: Treaty of Itaipu April 26 1973. Limitations: primary treaty text. https://itaipu.energy/wp-content/uploads/2022/02/Treaty_of_Itaipu.pdf

C27b - Itaipu 2024 tariff agreement and Annex C revision status (MME, Itamaraty, La Nacion)

Read level: full (2024 agreement text and La Nacion article of 27 Oct 2026); operator institutional page at search-result level. Supports: Annex C (the treaty's financial bases) required revision 50 years after the treaty's 13 August 1973 entry into force, i.e. from August 2023; the April-May 2024 bilateral understanding set the tariff at US$19.28/kW for 2024-2026, let Paraguay sell surplus power on Brazil's free market, and committed both sides to conclude the Annex C revision; the formal revision was not concluded in 2024 - talks were suspended April to November 2025 over the espionage row, resumed in December 2025, and remained unsigned as of late October 2026, with President Pena expecting to close the agreement with Brazil before the end of the year. Limitations: official announcements and news coverage; no revised Annex C text published; the legal state may change. https://www.gov.br/mme/pt-br/assuntos/noticias/brasil-e-paraguai-fecham-acordo-estrutural-para-tarifas-de-itaipu
https://concordia.itamaraty.gov.br/ApiConcordia/Acordo/integra-acordo-html/12813
https://www.itaipu.gov.br/noticias/institucional/ha-50-anos-tratado-de-itaipu-entrava-em-vigor-cinquentenario-abre-espaco-para-inicio-das-negociacoes https://www.lanacion.com.py/negocios/2026/10/27/pena-confia-en-cerrar-acuerdo-sobre-el-anexo-c-con-brasil-antes-de-fin-de-ano/

C29 - Kariba Dam Booklet (Zambezi River Authority)

Read level: search-result. Supports: Kariba: built 1956-59 across Zambezi for Zambia/Zimbabwe. Limitations: river authority booklet. https://www.zambezira.org/kdrp/sites/default/files/Kariba%20Dam%20Booklet-web.pdf

C30 - Dnipro Hydroelectric Station (Encyclopedia of Ukraine)

Read level: search-result. Supports: Dnipro HES: largest in Ukraine, built 1927-1932. Limitations: encyclopedia. https://www.encyclopediaofukraine.com/display.asp?linkpath=pages%5CD%5CN%5CDniproHydroelectricStation.htm

C31 - Tennessee Valley Authority Act, 1933 (National Archives)

Read level: search-result. Supports: TVA Act May 18 1933: flood control, navigation, cheap power. Limitations: primary doc archive. https://www.archives.gov/milestone-documents/tennessee-valley-authority-act

C32 - Grand Coulee Dam Visitor Center Exhibits (USBR)

Read level: search-result. Supports: Grand Coulee work began summer 1933. Limitations: operator. https://www.usbr.gov/pn/grandcoulee/visit/exhibits/scrapbooks/power/2.html

C34 - A Brief History of the Kaplan Turbine Invention (MDPI Energies)

Read level: search-result. Supports: MDPI Kaplan history: Kaplan turbine stems from Francis improvement attempts. Limitations: open-access journal. https://www.mdpi.com/1996-1073/14/19/6211

C35 - Hydropower Technology Brief (IRENA-ETSAP, 2015)

Read level: excerpt. Supports: IRENA ETSAP tech brief: potential energy to kinetic via penstock/turbine. Limitations: 2015 period tech brief. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA-ETSAP_Tech_Brief_E06_Hydropower.pdf

C35b - Hydroelectric Power: A Guide for Developers and Investors (World Bank PPP)

Read level: excerpt. Supports: World Bank PPP hydro guide: each plant custom-designed to site; civil works dominate. Limitations: developer guide. https://ppp.worldbank.org/sites/default/files/2021-10/Hydroelectric%20Power%20-%20A%20Guide%20for%20Developers%20and%20Investors.pdf

C36 - Power flow (Institution of Mechanical Engineers)

Read level: search-result. Supports: Niagara first large-scale AC transmission at hydro scheme. Limitations: professional body news. https://www.imeche.org/news/news-article/power-flow

C37 - Electrochemical Loads Served by Niagara Falls Hydropower (IEEE)

Read level: search-result. Supports: Adams Plant No.1 1895 polyphase station; 10 more years buildout. Limitations: IEEE periodical. https://doi.org/10.1109/mp.2020.3016101

C38 - 1975 Banqiao Dam failure (synthesis)

Read level: search-result. Supports: Banqiao event overview: August 1975, Typhoon Nina; 62 dams failed (2 large, 2 medium, 58 small); Banqiao breach outflow ~78,100-78,800 m3/s against 13,000 m3/s inflow; 701M m3 released in 6 h; 12,000 km2 inundated. Limitations: tertiary synthesis; headline mechanics consistent with the ASCE conference paper (C39). https://en.wikipedia.org/wiki/1975_Banqiao_Dam_failure

C39 - Lessons from Catastrophic Dam Failures in August 1975 in Zhumadian (ASCE)

Read level: abstract. Supports: Zhumadian 1975: max 5-day rainfall 1,631 mm; two large dams (Banqiao, Shimantan), two medium, 58 small failed by overtopping; Banqiao breach peak 78,100 m3/s, Shimantan 30,000 m3/s; 12,000 km2 inundated; over 26,000 dead (immediate); economic loss over RMB10 bn. Wider death-toll ladder: Henan preliminary 85,600 (under 100,000 total); CPPCC members 1980s 230,000; Human Rights Watch 1995 similar; ’171,000’ widely quoted mid-range without clear primary source; 10.75M affected. Limitations: ASCE conference paper abstract; the aftermath toll figures come from secondary sources attributed in the text. https://doi.org/10.1061/40971(310)20

C41 - Bath County Pumped Storage Station

Read level: search-result. Supports: Bath County: 3,003 MW max (6 units), 24,000 MWh storage; largest PSH 1985-2005 and again after 2009 uprate; cost about $1.6 bn (1977-1985). Limitations: tertiary summary; DOE corroborates headline figures. https://en.wikipedia.org/wiki/Bath_County_Pumped_Storage_Station

C43 - Aswan High Dam Resettlement of Egyptian Nubians

Read level: full. Supports: Aswan resettlement: 500km reservoir, >5,000 km2, Lake Nubia/Nasser. Limitations: academic repository. https://ndl.ethernet.edu.et/server/api/core/bitstreams/4ddc9a41-1fcf-4a71-8ee8-863b77c76f45/content

C44 - The Aswan High Dam and the International Rescue Nubia Campaign (Springer)

Read level: abstract. Supports: Aswan: first international UNESCO rescue campaign (Nubia). Limitations: Springer. https://link.springer.com/article/10.1007/s10437-007-9018-5

C44b2 - Building the Past: Rockscapes and the Aswan High Dam in Egypt

Read level: search-result. Supports: Aswan High Dam consequences: sediment capture, delta erosion, fertiliser substitution (academic review chapter). Limitations: Oxford Academic chapter. https://doi.org/10.1093/acprof:oso/9780199768677.003.0008

C45 - The World Bank’s Experience With Large Dams

Read level: search-result. Supports: World Bank dam approvals slowed by half from 1986-95 (39 projects incl dams). Limitations: Bank’s own review. https://documents1.worldbank.org/curated/en/537431493245604092/pdf/The-World-Banks-experience-with-large-dams-a-preliminary-review-of-impacts.pdf

C46 - Catastrophic Landslides of the 20th Century (USGS)

Read level: search-result. Supports: Vajont USGS: 250M m3 landslide, 2,000 killed, Longarone destroyed, $200M (1963$) damage. Limitations: USGS catalog. https://www.usgs.gov/programs/landslide-hazards/science/catastrophic-landslides-20th-century-worldwide

C47 - Aswan Dam Completed (National Geographic)

Read level: search-result. Supports: Aswan: British Low Dam 1902 preceded High Dam; High Dam post-1952 revolution for flood control; completed 1970. Limitations: educational resource. https://education.nationalgeographic.org/resource/aswan-dam-completed/

C48 - 2025 World Hydropower Outlook (IHA release)

Read level: full (PDF). Supports: IHA 2025 Outlook details: 14.3% share of world electricity; 150+ countries; 2.3M jobs; top-5 new-capacity countries 2024 China/Tanzania/Ethiopia/Bhutan/Pakistan; 60-70 GW below IRENA 2030 tripling path; Africa commissioned 4.5 GW 2024, ~11% of 600+ GW potential harnessed. Limitations: industry body. https://www.hydropower.org/news/flagship-2025-world-hydropower-outlook-out-now

C49 - China's Three Gorges Water Conservancy Complex

Read level: search-result. Supports: Three Gorges: 22,500 MW = 32x700 MW + 2x50 MW; designed avg 88.2 TWh/yr; record 111.8 TWh in 2020 passing Itaipu 2016 record on 15 Nov 2020 (CTG operator figures). Limitations: operator claims - attributed; some CTG material describes "750-MW" units, contradicted by the engineering literature figure of 700 MW used in this book. https://www.ctg.com.cn/ctgenglish/news_media/news37/2024080621160591105/index.html

C50 - Backgrounder: China's Three Gorges project (State Council, 2009)

Read level: full. Supports: Three Gorges official cost 184.9 bn yuan (~US$27.19 bn) "within budget" (2009); displacement 1.24M by Jun 2008, 1.27M by Jun 2009; resettlement spend 69.3 bn yuan; dam 181 m max height, 2,309.5 m axis; double-way five-step ship lock; vertical ship lift. Limitations: State Council office statement - official figure, unofficial totals higher. http://www.china.org.cn/government/central_government/2009-09/14/content_18518684.htm

C51 - Meets Foreign Pull (Boston University GCI Working Paper 017)

Read level: full. Supports: BU GCI WP017 (2021): CDB+CHEXIM lent over $44 bn for hydropower totalling over 27 GW across 38 countries, 2001-2020 (database); a Chinese industry-federation official claimed in 2019 that Chinese firms held over 70% of the international hydropower construction market (320 HPPs, 81 GW, 140 countries); net hydropower additions in China 281 GW in 2001-2019, 54% of world additions. Limitations: working paper; the market-share figure is an industry claim and is attributed as such in the text. https://www.bu.edu/gdp/files/2021/07/GCI_WP_017_FIN.pdf

C51b - D-CORE 2022-2025 (Green Finance & Development Center)

Read level: search-result. Supports: D-CORE 2022-2025 (Green Finance & Development Center): post-2021 no-overseas-coal pledge pivoted Chinese overseas energy finance to renewables; SOEs PowerChina/CEEC dominant; EPC ~75% of portfolio. Limitations: research center report. https://d-core.iigf.com.cn/reports/D-CORE_2022to2025.pdf

C52 - Klamath River Dam Removal and Restoration (CRS IF11616)

Read level: search-result. Supports: Klamath scope: largest dam removal/river restoration in US history (CA gov; CRS "largest and most complex of its kind to date in US"); 400+ miles salmon habitat; 2,200 acres restoration. Limitations: government + CRS. https://www.congress.gov/crs-product/IF11616

C53 - KHSA Implementation Report (PacifiCorp, 2020)

Read level: search-result. Supports: Klamath cost structure: KHSA cap $450M = up to $200M PacifiCorp customer surcharges + up to $250M CA Prop 1 bond; on budget. Limitations: PacifiCorp KHSA report 2020. https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/hydro/klamath-river/khsa-implementation/implementation-plans/2020.04.23_KHSA_ImpRptUpdate_2019.pdf

C55 - ResME model study on turbine degassing (JGR Biogeosciences, 2023)

Read level: abstract. Supports: ResME model JGR 2023: turbine degassing major poorly-constrained pathway; potential max degassing 11+/-4 Tg C/yr. Limitations: model, high uncertainty. https://doi.org/10.1029/2022jg006908

C56 - Greenhouse gas emissions (IHA factsheet)

Read level: search-result. Supports: IHA GHG factsheet: IPCC AR5 - only wind and nuclear lower median lifecycle GHG than hydro; emissions highest first 10-20 yrs; some reservoirs net sinks; IHA estimate 4+ bn t extra GHG/yr if hydro replaced by coal. Limitations: industry body citing IPCC - attribute. https://www.hydropower.org/factsheets/greenhouse-gas-emissions

C56b - G-res tool review (MDPI Sustainability, 2025)

Read level: abstract. Supports: G-res tool review (MDPI Sustainability 2025): numerical uncertainty, boreal over-representation, sign errors vs US field data. Limitations: review paper. https://www.mdpi.com/2071-1050/17/13/5794

C58b - Dam collapse that China kept secret (MCLC, Ohio State)

Read level: full. Supports: Banqiao secrecy: government kept news from national broadcast; full account emerged slowly. Limitations: MCLC/OSU. https://u.osu.edu/mclc/2019/02/18/dam-collapse-that-china-kept-secret/

C59 - China's Fengning pumped storage plant enters full operation (Xinhua/gov.cn)

Read level: search-result. Supports: Fengning PSH: 3,600 MW, 12 units (2 variable-speed, first in China), world's largest PSH, full operation 31 Dec 2024; 6.61 TWh/yr design. Limitations: Xinhua/gov.cn. https://english.www.gov.cn/news/202412/31/content_WS6773ab83c6d0868f4e8ee672.html

C60 - Dinorwig Power Station (ENGIE)

Read level: search-result. Supports: Dinorwig: 1,728 MW, six reversible units, opened 9 May 1984, built inside Elidir Fawr slate quarry, 16 km tunnels, full output ~12 s; largest PSH in Europe (operator claim). Limitations: operator ENGIE - attributed. https://www.engie.co.uk/dinorwig-power-station-en/

C61 - Hoover Dam Powerplant FAQs (USBR)

Read level: search-result. Supports: Hoover power: 2,080 MW nameplate, 17 Francis + 2 Pelton station-service units, ~4 bn kWh/yr; largest hydro installation 1939-1949. Limitations: USBR. https://www.usbr.gov/lc/hooverdam/faqs/powerfaq.html

C62 - Grand Coulee Dam Statistics and Facts (USBR, 2024)

Read level: search-result. Supports: Grand Coulee: 6,809 MW largest power station in US; >21 bn kWh/yr; gravity, 550 ft; built 1933-1941, third powerplant later; FDR Lake 82,300 acres/9.39M acre-ft. Limitations: USBR 2024 stats PDF. https://www.usbr.gov/pn/grandcoulee/pubs/2024-03-CGD-Stats-and-Facts.pdf

C62b - Russian Report Finds Hydroelectric Plant Catastrophe Resulted from Negligence (POWER)

Read level: search-result. Supports: Sayano-Shushenskaya: 6,400 MW, Russia's largest plant; Aug 17 2009 turbine failure flooded hall, 75 killed (POWERmag summary of official report). Limitations: trade press citing investigation. https://www.powermag.com/russian-report-finds-hydroelectric-plant-catastrophe-resulted-from-negligence-laxity/

C62c - China completes construction of second biggest hydro plant (Reuters)

Read level: full. Supports: Baihetan: 16 GW, 16 x 1,000 MW units, full operation Dec 2022, world's second-largest station. Limitations: Xinhua/CGTN + Reuters. https://www.reuters.com/business/sustainable-business/china-completes-construction-second-biggest-hydro-plant-2022-12-20/

C63 - Itaipu 2016 production record (Itaipu Binacional)

Read level: search-result. Supports: Itaipu: 14,000 MW = 20 x 700 MW; 2016 record 103.098 TWh; completed 1983; binational 50/50. Limitations: operator. https://www.itaipu.gov.br/noticias/energia/itaipu-fecha-ano-batendo-recorde-em-dezembro-e-tem-producao-historica-de-10309-milhoes-de-mwh

C64 - Guri (Simon Bolivar) hydroelectric plant

Read level: search-result. Supports: Guri/Simon Bolivar: 10,235 MW, 20 units two powerhouses; first stage 1969, expansion 1986; dam 7,426 m long, 162 m high; reservoir 4,250 km2 / ~135 km3; >60% of Venezuela electricity; third-largest capacity worldwide. Limitations: energia.com.ve + Wikipedia synthesis. https://en.wikipedia.org/wiki/Guri_(Sim%C3%B3n_Bol%C3%ADvar)

C65 - Aswan High Dam (NASA Earth Observatory)

Read level: search-result. Supports: Aswan High Dam: 2,100 MW; ~half Egypt's electricity in 1970 (NASA EO); rock/earth-fill 111 m high, 3,830 m crest, 980 m base, ~43M m3; completed 1970; Lake Nasser ~162-169 km3, ~6,000 km2; Soviet funding after US/UK withdrew 1956. Limitations: NASA EO + Britannica + ICE; ILEC lists a conflicting 2,325 m crest figure; the 3,830 m figure is used in this book. https://science.nasa.gov/earth/earth-observatory/aswan-high-dam-85992/

C66 - Kariba HES Technical Data (Zambezi River Authority)

Read level: search-result. Supports: Kariba: double-curvature arch 128 m high, 617 m crest, 1.036M m3 concrete; 1,080 + 1,050 = 2,130 MW; reservoir max retention 185 km3 (supports "world's largest man-made reservoir by volume" claim); built 1956-59. Limitations: Zambezi River Authority. https://zambezira.org/hydro-electric-schemes/kariba-hes/kariba-hes-technical-data

C68 - 30 years history of Roller-Compacted Concrete dams in Japan

Read level: abstract. Supports: RCC: world’s first roller-compacted concrete dam built in Japan 1980; ~40 since. Limitations: Taylor&Francis chapter abstract. https://doi.org/10.1201/9780203741276-3

C69 - Upper Stillwater Dam RCC mix design (USBR)

Read level: search-result. Supports: USBR: Upper Stillwater Dam first USBR dam built by RCC method (1980s). Limitations: agency doc. https://digitalcommons.usu.edu/govdocs_dams/1/

C70 - Design of Spillways and Outlet Works for Dams (EOLSS)

Read level: search-result. Supports: Spillway purpose: pass moderate floods and prevent dam failure in major floods. Limitations: EOLSS sample chapter. https://www.eolss.net/Sample-Chapters/C07/E2-15-04-10.pdf

C71 - River Diversion (engineering textbook)

Read level: search-result. Supports: River diversion types: tunnel around site vs channel across site; diversion essential to build in river channel. Limitations: textbook PDF. https://www.uoanbar.edu.iq/eStoreImages/Bank/1885.pdf

C72 - Power flow (IMechE)

Read level: full. Supports: IMechE “Power flow”: Niagara first large-scale AC transmission from a hydro scheme; DC era ended at 1891 Frankfurt exhibition. Limitations: professional body. https://www.imeche.org/news/news-article/power-flow

C73 - Oroville Dam Spillway Incident: Independent Forensic Team final report

Read level: summary-level. Supports: Oroville IFT final report Jan 2018: no single root cause; physical + human/institutional factors. Limitations: forensic team report summary. https://water.ca.gov/Programs/State-Water-Project/SWP-Facilities/Oroville/Oroville-Spillways/Forensic-Team

C74 - Oroville incident record (ASDSO)

Read level: search-result. Supports: Oroville Feb 2017: 188,000 evacuated (ASDSO incident record). Limitations: dam-safety body. https://damsafety.org/incidents/ca00035-3097

C75 - The second century CE Roman watermills of Barbegal (Science Advances)

Read level: abstract. Supports: Barbegal: 16 water wheels, second century CE, fed by Arles aqueduct; regarded among first industrial complexes. Limitations: Science Advances 2018. https://www.science.org/doi/10.1126/sciadv.aar3620

C82 - Chinese dams held back Mekong waters during drought, study finds (Reuters, 2020)

Read level: full. Supports: Eyes on Earth satellite study (US-government funded) reported by Reuters Apr 2020: China’s 11 upper Mekong dams held back water during the 2019 drought despite above-average upstream rain and snowmelt; downstream levels up to 3 m below natural-model predictions; 47 bn m3 combined reservoir capacity; no formal water treaties with lower Mekong countries; US officials say Beijing effectively controls the river. Limitations: single study; disputed by China; US-government funded. https://www.reuters.com/article/us-mekong-river/chinese-dams-held-back-mekong-waters-during-drought-study-finds-idUSKCN21V0U7/

C83 - Why China’s neighbours are worried about its new mega-dam project (Reuters, 2025)

Read level: full. Supports: Reuters Jul 2025: China broke ground on the Yarlung Zangbo mega-dam (world’s largest, US$170 bn, five dams, first power early-to-mid 2030s); the river becomes the Brahmaputra in India and Bangladesh; Indian officials fear for water security (Arunachal CM: could dry out 80% of the river in the state); experts warn Beijing’s opacity fuels conflict cut-off speculation. Limitations: project details unpublished; claims attributed. https://www.reuters.com/world/china/why-chinas-neighbours-are-worried-about-its-new-mega-dam-project-2025-07-22/

Additional sources consulted

C7 - Hydropower (IRENA)

Read level: full. Scope: IRENA: global hydro capacity 1,283 GW in 2024 excl PSH; +15 GW 2024; LCOE framing. Limitations: agency page, 2024 basis. https://www.irena.org/Energy-Transition/Technology/Hydropower

C9 - GSR 2025 Hydropower factsheet (REN21)

Read level: search-result. Scope: REN21 GSR 2025: 15.1 GW new 2024, total 1,253 GW. Limitations: factsheet highlight only. https://www.ren21.net/gsr-2025/downloads/pdf/supply/GSR_2025_Factsheet_Supply_Hydropower.pdf

C12 - Vajont Dam (Italy, 1963) case study

Read level: search-result. Scope: Vajont: dam on Vajont river upstream of Longarone; 1963. Limitations: dam-failure case study body. https://damfailures.org/case-study/vajont-dam-italy-1963

C13 - Vajont Dam

Read level: search-result. Scope: Vajont: 9 Oct 1963 initial filling; 50M m3 water overtopped in 250m wave. Limitations: tertiary. https://en.wikipedia.org/wiki/Vajont_Dam

C20 - The Project (Klamath River Renewal Corporation)

Read level: search-result. Scope: KRRC removed JC Boyle, Copco No.1, Copco No.2, Iron Gate (PacifiCorp-owned). Limitations: project entity. https://klamathrenewal.org/the-project/

C22 - Tribes celebrate the end of the largest dam removal project in US history (AP)

Read level: search-result. Scope: largest dam removal project in US history completed (Oct 2024). Limitations: news. https://apnews.com/article/klamath-dam-removal-completed-tribes-435b955f5bfdeaca82de66bfc6551ba1

C25 - Lessons from China’s Three Gorges Dam (Gleick, 2009)

Read level: search-result. Scope: Three Gorges: 175 m final reservoir level; 27M m3 cement (Gleick 2009). Limitations: period source. https://doi.org/10.1017/s1557466009008973

C28 - The Guri Hydroelectric Power Plant Project, Venezuela (Power Technology)

Read level: search-result. Scope: Guri: on Caroni river, Necuima Canyon, 100km upstream. Limitations: trade press. https://www.power-technology.com/projects/gurihydroelectric/

C40 - Criminal Proceedings of the Vajont Dam Disaster (UNESCO Memory of the World)

Read level: search-result. Scope: UNESCO Memory of the World: Vajont criminal proceedings records. Limitations: UNESCO. https://www.unesco.org/en/memory-world/criminal-proceedings-vajont-dam-disaster

C42 - Pumped Storage (National Hydropower Association)

Read level: search-result. Scope: PSH 179 GW in 2023 (IHA 2024 outlook) +6.5 GW. Limitations: trade body. https://hydro.org/waterpower/pumped-storage/

C67 - Grand’Maison hydropower site (EDF)

Read level: search-result. Scope: Grand Maison (France): 1,800 MW PSH, larger than Dinorwig’s 1,728 MW, so claims that Dinorwig is Europe’s largest PSH are outdated. Limitations: EDF operator pages. https://www.edf.fr/groupe-edf/comprendre/production/hydraulique/stations-de-transfert-d-energie-par-pompage