

Renewables

Solar, wind, hydro, geothermal, ocean, bioenergy

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Solar PV & Concentrated Solar Power

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-001
iea_category	energy_supply
technology	Solar PV & Concentrated Solar Power
technology_readiness	commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA classifies solar photovoltaic (PV) and concentrated solar power (CSP) as core renewable energy supply technologies. Solar PV converts sunlight directly into electricity using semiconductor cells, while CSP uses mirrors or lenses to concentrate sunlight and generate thermal energy for power production. The ETP Clean Energy Technology Guide places solar PV among the most mature and rapidly scaling clean energy technologies globally.

Technology Readiness & Deployment

Solar PV is fully commercial and the fastest-growing power generation technology worldwide. Global installed capacity exceeded 1,600 GW by end-2024, with annual additions surpassing 400 GW. CSP remains at early commercial stage with approximately 7 GW installed globally, primarily in Spain, the United States, and MENA. The IEA Tracking Clean Energy Progress rates solar PV as on track for the Net Zero Emissions scenario, while CSP requires additional policy support.

Key Metrics & Benchmarks

Utility-scale solar PV LCOE has fallen below USD 30/MWh in optimal locations, making it the cheapest source of new electricity in most markets. Module costs have declined over 99% since 1976. CSP with thermal storage can provide dispatchable power at USD 80-120/MWh. China dominates the PV manufacturing supply chain, producing over 80% of wafers, cells, and modules globally.

LATAM Relevance

Latin America has exceptional solar resources, particularly in the Atacama Desert (Chile), northeastern Brazil, and northern Mexico. Chile leads regional solar deployment with over 10 GW installed capacity, including the region's first CSP plants. Brazil's distributed solar PV market is among the fastest-growing globally, driven by net metering policies. Colombia's La Guajira region offers strong solar potential still largely untapped.

Critical Minerals Link

Solar PV manufacturing requires silicon (polysilicon for wafers), silver (cell metallization), copper (wiring and inverters), and aluminium (frames). CSP depends on steel, glass, and specialized heat-transfer fluids. Chile and Peru supply copper essential for solar system balance-of-plant components.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — solar generation and grid integration; IN (Industry) — PV manufacturing and supply chain; XS (Cross-Sectoral) — distributed generation across buildings and industry.

Wind (onshore & offshore)

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-002
iea_category	energy_supply
technology	Wind (onshore & offshore)
technology_readiness	commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA classifies wind energy under renewable electricity supply, distinguishing onshore and offshore wind as separate technology tracks. Onshore wind uses turbines installed on land to convert kinetic wind energy into electricity, while offshore wind deploys turbines in marine environments (fixed-bottom or floating). Both are categorized as mainstream clean energy technologies in the ETP Clean Energy Technology Guide.

Technology Readiness & Deployment

Onshore wind is fully commercial with over 1,000 GW installed globally. Offshore wind has reached early commercial maturity, with approximately 75 GW installed, led by China, the UK, and Northern Europe. Floating offshore wind remains at demonstration stage with less than 200 MW deployed. The IEA tracks wind as broadly on track for net zero but flags permitting delays and supply chain bottlenecks as risks to meeting 2030 targets.

Key Metrics & Benchmarks

Onshore wind LCOE ranges from USD 25-50/MWh in favorable locations. Offshore wind costs have fallen to USD 60-100/MWh for fixed-bottom installations. Modern onshore turbines reach 6-7 MW capacity with rotor diameters exceeding 170 meters. Offshore turbines now exceed 15 MW per unit. Capacity factors range from 25-

45% onshore and 40-55% offshore.

LATAM Relevance

Brazil is Latin America's wind leader with over 30 GW installed, primarily onshore in the northeast. Colombia's La Guajira region has world-class wind resources with several GW of projects under development. Chile and Argentina also have significant onshore wind potential in Patagonia and central regions. Offshore wind is nascent in LATAM but Brazil and Colombia have begun regulatory frameworks for offshore development.

Critical Minerals Link

Wind turbines require rare earth elements (neodymium and dysprosium for permanent magnet generators), copper (generators and cabling), steel (towers), and fiberglass or carbon fibre (blades). Offshore installations require significantly more copper for subsea cables. Brazil holds notable rare earth reserves that could support regional wind supply chains.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — wind generation, grid integration, and offshore infrastructure; IN (Industry) — turbine manufacturing and installation; XS (Cross-Sectoral) — hybrid wind-storage systems.

Hydropower, Tidal & Wave

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-003
iea_category	energy_supply
technology	Hydropower, Tidal & Wave
technology_readiness	commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA groups hydropower, tidal, and wave energy under renewable electricity technologies that harness the energy of water. Hydropower (conventional and pumped storage) is the largest source of renewable electricity globally. Tidal and wave (ocean energy) technologies convert marine kinetic and potential energy into electricity through various mechanisms including tidal barrages, tidal stream turbines, and wave energy converters.

Technology Readiness & Deployment

Conventional hydropower is a mainstream technology with over 1,400 GW installed globally. Pumped storage hydropower provides about 160 GW of grid-scale storage capacity. Hydropower installations more than doubled to over 25 GW in 2024, driven by large projects in China, Africa, and Southeast Asia. Ocean energy (tidal and wave) remains at demonstration or early commercial stage with less than 1 GW deployed globally and is not on track per IEA assessments, requiring rapid scale-up in policy support.

Key Metrics & Benchmarks

Hydropower LCOE ranges from USD 20-80/MWh depending on site and scale. Pumped storage provides 4-12 hours of discharge at costs of USD 50-150/MWh. Capacity factors for conventional hydro average 40-60%.

Hydropower accounts for approximately 3% of projected new renewable power additions to 2030, while pumped storage is seeing faster growth between 2025-2030 than the previous five years.

LATAM Relevance

Latin America depends heavily on hydropower, which supplies over 45% of the region's electricity. Brazil has the world's third-largest hydropower fleet (over 110 GW), and Colombia, Peru, and Chile rely significantly on hydroelectric generation. Climate variability and drought increasingly threaten hydro-dependent grids, making diversification urgent. Pumped storage potential exists across the Andes and Brazilian highlands.

Critical Minerals Link

Hydropower requires large quantities of steel and concrete for dams and infrastructure, copper for generators and transmission, and aluminium for structural components. Ocean energy devices require steel, copper, and specialized marine-grade materials. The mineral intensity per MWh is relatively low compared to other renewables.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — hydroelectric generation, pumped storage, ocean energy; XS (Cross-Sectoral) — water-energy nexus, climate adaptation of hydro assets.

Geothermal

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-004
iea_category	energy_supply
technology	Geothermal
technology_readiness	commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA classifies geothermal energy as a renewable technology that harnesses heat from the Earth's interior for electricity generation and direct heating applications. The ETP Technology Guide distinguishes conventional hydrothermal systems (commercial) from enhanced geothermal systems (EGS), which are at demonstration stage. Geothermal provides baseload renewable power with capacity factors exceeding 80%.

Technology Readiness & Deployment

Conventional geothermal power is commercially deployed with approximately 16 GW installed globally, led by the United States, Indonesia, the Philippines, Turkey, and Kenya. The IEA projects annual geothermal capacity additions will reach historic highs by 2030, tripling the 2024 rate. However, the IEA rates geothermal as not on track for net zero targets, requiring a rapid step-up in investment and policy support. Enhanced geothermal systems show promise but remain pre-commercial.

Key Metrics & Benchmarks

Geothermal LCOE typically ranges from USD 50-100/MWh for conventional hydrothermal. Capacity factors of 80-95% make geothermal the most reliable renewable source for baseload power. Direct-use geothermal for heating

serves over 100,000 thermal MW globally. The technology produces minimal lifecycle greenhouse gas emissions compared to fossil baseload alternatives.

LATAM Relevance

Latin America sits on the Pacific Ring of Fire, giving it significant geothermal potential. Mexico has the fourth-largest geothermal capacity globally (approximately 1 GW at Cerro Prieto). Chile, Colombia, Peru, and Central American nations have identified substantial untapped geothermal resources along the Andes. Colombia's Nevado del Ruiz and Chiles-Cerro Negro systems are under exploration.

Critical Minerals Link

Geothermal systems require steel and specialized alloys for well casings and piping resistant to high-temperature corrosive fluids. Copper is used in generators and power plant equipment. Geothermal brines can contain lithium as a byproduct, creating potential co-extraction opportunities relevant for battery mineral supply chains, particularly in Chile and Argentina.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — geothermal power generation and direct heat; BU (Buildings) — district heating from geothermal; IN (Industry) — industrial process heat from geothermal sources.

Bioenergy & Synthetic Fuels

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-005
iea_category	energy_supply
technology	Bioenergy & Synthetic Fuels
technology_readiness	early_commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA classifies bioenergy as energy derived from biomass sources — including agricultural residues, forestry waste, energy crops, and organic waste — used for power, heat, and transport fuels. Synthetic fuels (e-fuels) are produced by combining green hydrogen with captured CO₂ to create drop-in hydrocarbon replacements. The ETP Technology Guide categorizes advanced biofuels and synthetic fuels as key alternative fuels for hard-to-abate sectors.

Technology Readiness & Deployment

Conventional bioenergy (biopower, bioethanol, biodiesel) is commercially deployed globally, accounting for approximately 6% of global energy supply. Advanced biofuels (cellulosic ethanol, bio-jet fuel) are at early commercial stage with limited production capacity. Synthetic fuels remain largely at demonstration or pilot stage, with global production below 1,000 tonnes per year. The IEA flags both advanced biofuels and e-fuels as needing significantly faster deployment to meet net zero targets.

Key Metrics & Benchmarks

Biopower LCOE ranges from USD 50-120/MWh. Bioethanol production exceeds 100 billion litres annually, led by the United States and Brazil. Sustainable aviation fuel (SAF) production reached approximately 1 billion litres in 2024 but needs to scale tenfold by 2030. Synthetic fuel production costs remain high at USD 3-6 per litre, requiring cheaper green hydrogen and CO2 capture to become competitive.

LATAM Relevance

Brazil is the world's second-largest bioethanol producer and a pioneer in sugarcane-based bioenergy, with a mature flex-fuel vehicle fleet and extensive biomass power generation. Colombia has mandated biodiesel and ethanol blending in transport fuels. The region's abundant biomass resources and low-cost renewable electricity make LATAM a potential hub for advanced biofuels and green hydrogen-based synthetic fuel production.

Critical Minerals Link

Bioenergy has low critical mineral intensity compared to other energy technologies. Catalysts for advanced biofuel and synthetic fuel production use platinum group metals (PGMs) and nickel. Electrolyser components for green hydrogen (needed for e-fuel synthesis) require iridium and platinum, with supply chain risks.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — biopower and biomass heating; TR (Transport) — biofuels and synthetic aviation fuels; IN (Industry) — biomass for industrial process heat; XS (Cross-Sectoral) — waste-to-energy systems.

Nuclear (incl. SMRs)

Source Metadata

Field	Value
source	iea
source_version	ETCS 2025
source_id	IEA-SUP-006
iea_category	energy_supply
technology	Nuclear (incl. SMRs)
technology_readiness	commercial
mitigation	Y
adaptation	N
last_checked	2026-05-26

IEA Technology Definition

The IEA classifies nuclear energy as a low-carbon dispatchable electricity source using controlled nuclear fission. The technology is split between conventional large-scale reactors (Generation III/III+) and Small Modular Reactors (SMRs) with capacities below 300 MW. The ETP Technology Guide positions conventional nuclear as a mature technology and SMRs as an emerging technology at demonstration to early commercial readiness.

Technology Readiness & Deployment

Conventional nuclear power operates approximately 440 reactors globally with around 390 GW of installed capacity. New large reactor construction continues in China, India, Egypt, Turkey, and the UK. SMRs have seen a surge of interest, with conditional offtake agreements between data centre operators and SMR developers growing from 25 GW at end-2024 to 45 GW by mid-2025. China and Russia have operational SMR-type designs, while NuScale, Rolls-Royce, and others are in advanced licensing stages.

Key Metrics & Benchmarks

Large nuclear plant LCOE ranges from USD 40-100/MWh with capacity factors typically above 80%. SMR cost projections range from USD 60-120/MWh but remain unproven at commercial scale. Nuclear provides

approximately 10% of global electricity and about 25% of low-carbon electricity. Typical construction timelines are 7-12 years for large reactors; SMRs aim for 3-5 year build cycles through factory fabrication and modular assembly.

LATAM Relevance

Argentina, Brazil, and Mexico operate nuclear power plants, with Argentina pioneering the CAREM-25 small modular reactor, one of the most advanced SMR projects globally. Brazil is constructing Angra 3 to expand its nuclear fleet. Chile and Colombia have explored nuclear feasibility studies. Nuclear can complement variable renewables in LATAM grids, providing firm low-carbon baseload power.

Critical Minerals Link

Nuclear energy requires uranium fuel, zirconium alloys for fuel cladding, hafnium for control rods, and specialized steel for pressure vessels. SMRs may use high-assay low-enriched uranium (HALEU). Latin America has uranium deposits in Brazil and Argentina, though most supply comes from Kazakhstan, Canada, and Australia.

Cleantech Taxonomy Crosswalk

Maps to Cleantech Taxonomy sectors: ES (Energy Systems) — nuclear power generation, SMR deployment, grid stability; IN (Industry) — nuclear-powered industrial heat (SMR applications); XS (Cross-Sectoral) — hydrogen production via nuclear heat.