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ENERGY OUTLOOK

The Future of Green and Clean Energy Technology in Bangladesh



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Introduction to Green Energy Technology

As Bangladesh strives for a sustainable future, green energy technologies—including solar, wind, and nuclear energy—are essential for tackling climate change and powering growth. With abundant resources, Bangladesh is tapping into solar power, developing wind energy along its coasts, and advancing nuclear energy to meet its growing demand for clean, reliable power.

This Energy Outlook covers the following topics where we explore how these technologies are transforming the energy landscape and shaping Bangladesh's future.



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Mohammad Iftexharul Islam & Md. Tuhin Ahmed



Editor

Israt Hossain

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Next Generation Solar Power in Shaping the Sustainable Future of Bangladesh

Sheikh Tausif Ahmed & Nafis Mubarrat

In recent years, Bangladesh has made good headway into renewable energy production. Sustainable and Renewable Energy Development Authority (SREDA) of Bangladesh estimates that 5% of the total energy generation capacity now comes from renewables. Solar energy is the primary contributor of renewable energy in Bangladesh, accounting for 82% of the renewable energy generated. Rooftop solar is steadily expanding and 3,989 net-metered systems across the nation has been installed till date. Large-scale solar parks are also playing a major role.

Despite these advances, Bangladesh still has massive solar energy potential which remains untapped. Experts estimate the potential to be 50,174 MW, enough to meet about 80 percent of the country's projected energy demand of 60,000 MW by 2041. The urgency to exploit these energy potentials is exacerbated by the recent energy crisis Bangladesh is facing. In a policy shift towards the right gear, the government announced ambitious plans in its Renewable Energy Policy in June 2025, which aims to achieve 20% renewable energy by 2030 and 30% by 2040.

While conventional methods in solar energy generation like rooftop solar is in high demand, alternative and more effective solutions need to be explored to increase the share of renewable energy in the overall energy mix. In the context of growing innovation, advances in solar, storage and smart-grid technologies offer the potential to leapfrog traditional power systems. For example, Perovskite solar cells are a new type of photovoltaic (PV) material that can convert up to 50 percent more sunlight into electricity than conventional silicon panels. Which is why they are ideal for low-light conditions,

especially during monsoon seasons in Bangladesh. These cells are lightweight and can be printed or spray-coated, allowing innovative applications such as applying "solar paint" to roofs or walls. Unlike traditional silicon PV, perovskites can be processed near room temperature, which drastically cuts manufacturing energy and costs. Such high-efficiency, low-cost PV could allow Bangladesh to expand capacity within limited rooftop and urban spaces and reduce solar adoption costs for households, industries, and SMEs.

Alongside perovskites, other emerging technologies such as thin-film and organic photovoltaics (OPV) offer distinctive advantages. They are lightweight, flexible, and inexpensive to manufacture. Thin-film cells can be fabricated on rolls or plastic surfaces, which makes them suitable for curved roofs, portable devices, or building-integrated solar windows. In Bangladesh, thin-film modules could be used on lightweight rooftops and building exteriors where heavier panels are unsuitable, while OPV films could provide power for village shops and small electronic devices.

Solar technology, especially solar farms, usually requires more landmass than conventional power plants. However, with one of the world's highest population densities, Bangladesh has limited land available. To overcome land constraints, floating photovoltaic (FPV) systems enable solar deployment on reservoirs, lakes, and ponds. As a riverine country, this could be a feasible production method for Bangladesh. Water acts as a natural coolant and improves panel efficiency and durability while

simultaneously cutting evaporation and algae growth. Bangladesh is already planning to put up an FPV plant in Bagerhat. This modular, scalable approach can quickly add generation capacity without displacing farmers or using dry land.

Agrivoltaics offers another innovative solution to land constraints by integrating solar panels with crops on the same land. Elevated photovoltaic arrays create dual-use fields where crops grow in partial shade and solar panels generate electricity. Studies show this approach can increase land productivity, reduce water needs, and, all the while, raise the total combined yield of rice and solar by 35 to 73%. In Bangladesh, trials on BRRI-33 rice show that intermittent shading does not reduce yields and can improve plant growth, soil conditions, and water retention. A 100 MW semi-agrivoltaics project is already in the works in Jamalpur, where green chilies, turmeric, and ginger will be cultivated beneath solar panels.

As an alternative to photovoltaic technology, we can also use solar thermal systems for renewable power generation. For instance, thermoelectric generators can convert heat from the sun directly into electricity. Other solar thermal technologies, such as concentrating solar power (CSP), use mirrors or lenses to heat fluids and drive turbines. Unlike photovoltaic systems, CSP can store solar energy as heat using molten-salt storage and supply electricity on demand. Which can be very useful for Bangladesh, as it can utilize this energy when there is a lack of solar power. Feasibility studies in Bangladesh, especially the Dinajpur region, showed large potential for CSP.

Apart from CSP, other storage technologies have been developed, especially to store photovoltaic power. Flow batteries store energy in liquid electrolytes contained in external tanks, separating power capacity from storage volume. They offer exceptionally long lifetimes of tens of thousands of cycles and allow full depth-of-discharge. Flow batteries may have lower energy density than lithium-ion, but they are well-suited for large-scale, multi-hour grid storage and can smooth daily or weekly renewable fluctuations with little degradation. Bangladesh currently has no grid-scale flow battery installations, but falling costs could make them a practical option for island grids or long-duration solar storage. Among long-duration storage options, pumped-storage hydropower (PSH) is the most established technology. It works by using

surplus electricity to pump water uphill into a reservoir and later releasing it to drive turbines when demand rises. PHS offers large capacity at a relatively low cost per kilowatt-hour and can operate reliably for decades. Bangladesh currently has no PHS plants, though potential sites have been studied, and the 2016 Power System Master Plan has set a target for the first project by 2030. Locations such as Kaptai where an existing hydro dam already operates, or reservoirs in the hilly northeast could provide gigawatt-hour scale storage.

Modernizing the power grid is critical to support the integration of renewable energy. Smart grid systems use digital sensors, automated controls, and real-time data to optimize electricity flows and accommodate intermittent renewables. In Bangladesh, U.S. funded studies have already launched pilot projects in Dhaka and at the national transmission level, aiming to create a more efficient and flexible grid. The 2025 net-metering reforms in Bangladesh represent an important step forward. The new policy allows homes and businesses to use rooftop solar for own use and contribute the excess solar to the national grid. If a user is a net exporter, i.e. provides excess solar energy in the system, then they receive energy credits which they can use to purchase electricity from the grid. These changes encourage more people to produce their own electricity. Combined with smart-grid investments, progressive net-metering will help Bangladesh better distribute and manage its growing renewable energy capacity.

Bangladesh stands at a pivotal moment: gains in solar, bold targets, and diverse applications show momentum, yet vast potential remains untapped. Next-generation options—perovskites, OPV, FPV and agrivoltaics—can overcome land and cost constraints, while CSP, flow batteries and pumped-storage provide storage solutions. Realizing this vision requires modern grids, scalable finance, and stable rules—building on net-metering reforms and accelerating pilots to bankable projects. With coordinated policy, de-risked investment and local R&D, Bangladesh can leapfrog legacy systems, lower costs, and boost resilience. Seizing this opportunity will not only deliver cleaner power but also help reduce energy dependency on foreign markets and offer pathways for sustainable economic growth.

Sheikh Tausif Ahmed, Research Associate, SANEM
Email: sheikhtausif897@gmail.com
Nafis Mubarrat, Programme Associate, SANEM.
Email: nafis.sanem@gmail.com

Advanced Wind Turbine Solutions for Bangladesh's Tomorrow

Sudeep Roy & Israt Hossain

Bangladesh is entering a crucial phase of its energy journey amidst increasing energy demand and environmental challenges. This developing economy is highly dependent on fossils. According to Petrobangla, the natural gas consumption in FY 2024-25 till June was approximately 900.4 billion cubic feet, with the power sector being the largest consumer. This has led not only to greenhouse gas emissions but also to the rise of the cost of energy imports. In FY 2023-24, about 5.137 million tons of LNG were imported, and this number rose to 5.808 million tons in FY 2024-25. Wind power is becoming a more practical choice as Bangladesh moves towards renewable energy sources.

Bangladesh has a considerable potential for wind energy resources, but the development of the wind energy sector is still emerging, with the slow pace of growth limited by the high regulatory and investment uncertainty situation and context. Currently, there are 15 wind energy projects either in operation or in the planning stages, with a total capacity of 777.902 MWp, according to the SREDA. Bangladesh's first commercial wind power plant began its full-scale operation in March 2024. This marked a significant milestone for Bangladesh for its transition towards renewable energy. Some other projects are underway, including the 100 MW Anwara Wind Power in Chittagong, which is currently in the planning stages. This is expected to contribute significantly to the country's renewable energy capacity by 2035. In addition, the 100 MW Wind Power Plant in Matarbari is set to be completed in 2026 as well as 200 MW Wind Power Plant in Chakaria.

Plans are also underway for 50 MW wind power plants in Chandpur and Feni.

Current wind energy is approaching a major transformation due to recent revolutionary innovations in harnessing wind, transforming electricity generation, and driving down costs. These developments mean we are not only edging towards higher efficiencies, but they are also bringing wind power closer to accessibility and affordability than ever. Optimization of turbines for aerodynamic performance is highlighted as a key research theme in wind technology today, with increased turbine efficiency via improved blade design and materials a primary focus area. Another sector that is continuing to evolve is the designs of the blades, for they are creating new blade designs that provide an optimal aerodynamic profile that captures more wind energy over a wider range of wind speeds.

Some notable advancements are implemented, such as variable pitch and twist technologies, enabling blades to continuously vary to changing wind conditions over their entire span, optimizing performance, minimizing mechanical loads, and increasing their life span. At present, the shift towards advanced materials is crucial. Today, most turbine blades are made of composite materials such as fiberglass and carbon fiber with good strength-to-weight ratios. This progress enables building larger blades that can capture more wind energy whilst also extending operational lifetime and reducing maintenance costs. Towers of wind turbines have identified them at early heights of above 160 meters.

allowing for wind rotors with diameters (e.g., 150 meters) to access higher altitude winds with increased strength. Segmenting blades reduces their impact on transport, a key factor in lowering installation costs since long blades improve the energy capture per turbine.

One of the approaches to overcome limitations associated with regions with lower wind resources like Bangladesh is a concept called Low Wind, which uses special turbines for low wind speeds. The goal of this design is to produce power when traditional windfarms are not producing, and get rid of that "cannibalization effect" responsible for making electricity less expensive when suddenly all farms produce at the same time. Low Wind turbines are identified by their very-long blades to optimize power at the lowest wind speed, and low cut-out speed (around 12–13 m/s).

Bangladesh can take advantage of the state-of-the-art technologies in wind turbines to enhance its renewable energy capacity. According to a detailed study conducted in 2018 by the US Department of Energy's National Renewable Energy Laboratory, Bangladesh has wind energy potential of at least 30,000MW. Vietnam is a place with a lot of potentials when it comes to wind energy thanks to its geographical position, favourable topography, long coastline, and high sea wind speed. The coastline is 710 km, and the southwestern part incorporates the untainted Sundarbans mangrove timberland and St. Martin's coral island in the southeastern part. In the south lies the Bay of Bengal, where floating wind farms can be positioned further out from shore, where fixed wind turbines cannot reach. If we'd build the seaside windfarms, for instance using 153-meter blades, we could cover a lot of homes simultaneously. Residential areas are best suited for bladeless turbines. They are easily manageable because they are small, quiet, and less demanding.

The adoption of wind power is expected to speed up the development trajectory for Bangladesh, as it will not only be a green energy for households but also a powerhouse for the national economy. the growing wind power industry is also expected to nurture a

new generation of trained workers, from engineers and maintenance staff to power managers, is another factor weighed for the country's development. Also, the environmental benefits of wind power go far beyond simply reducing carbon emissions. With an increasing demand and production of wind farms, the country will rely less on imported fossil fuels. This shift promises much cleaner air because burning coal releases toxic pollutants like sulfur dioxide (SO₂) and nitrogen oxides (NO_x), which conventional power plants continuously spew into the atmosphere daily.

Although there may still be some reliance on traditional sources in the short term, every step forward is crucial. And in the end, wind's coming-of-age can mean solid green footings for a cleaner future and a better way of life as Bangladesh fights even harder for its place in a clean world. Bangladesh can lead the way in the deployment of advanced wind technologies with floating offshore farms and low-wind turbines, thus creating energy independence, new industries, and sustainable economic development, while ensuring its climate future and a large reduction in national emissions.

Sudepto Roy, Research Associate, SANEM.

Email: sudeptoroy232@gmail.com

Israt Hossain, Director at SANEM

Email: hossain.israt698@gmail.com



Bangladesh's Energy Transition: Betting Big on Nuclear

Mohammad Iftekharul Islam & Md. Tuhin Ahmed

Bangladesh's economy and its energy demand are growing rapidly in tandem. Along with this, the quest for reliable power is becoming a critical energy policy concern. The industrial sector has become the single largest consumer of energy, and demand is projected to keep climbing as industrial activities expand. At the same time, the government has been successful in extending electricity access from residential to industrial levels, which has added more pressure on the grid than ever before.

After industry and households, the transport sector currently consumes the third most energy, and demand is rapidly increasing. Road transport contributed to 74-76% of the total transportation fossil fuel emissions, and the primary fuel here is diesel. The expansion of the industrial and transportation sectors is significantly increasing electricity and fuel demand, putting a strain on the national power grid more than ever. Unless reliance on imported fossil fuels such as oil, coal, and LNG (which account for over 98%) is reduced, Bangladesh risks increased grid stress and energy insecurity.

Price volatility in the global fuel market creates fiscal pressure and foreign exchange risks. Heavy reliance on such imported fuels undermines energy security and raises risks of supply disruptions. Continued fossil fuel use also does not align with the COP26 pledge of Bangladesh to move towards decarbonisation. High dependence on fossil fuels also risks carbon lock-in, which makes long-term climate goals harder to achieve.

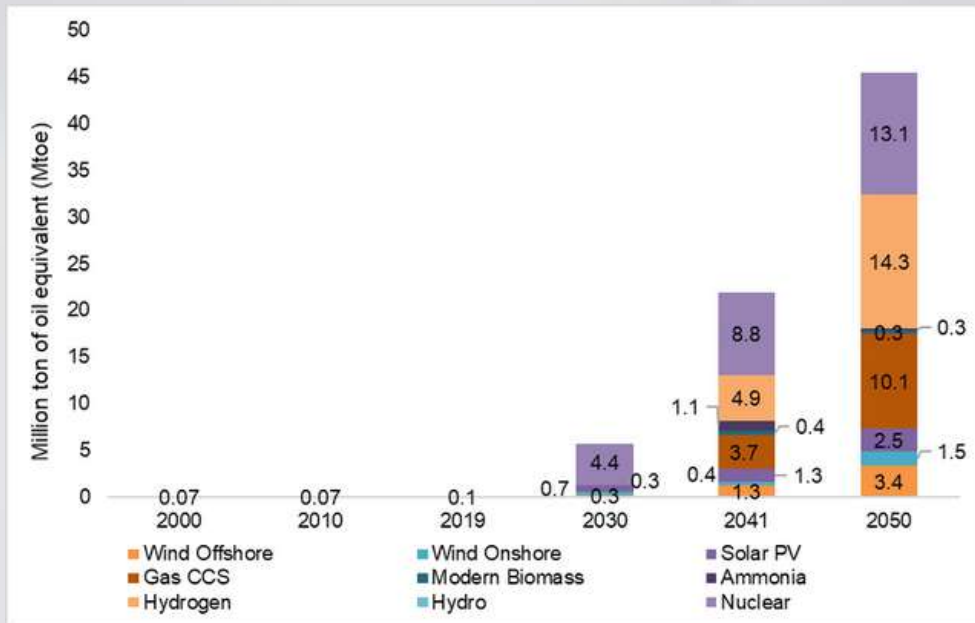
Industries face high energy costs from imported fuels, particularly as gas shortages force a shift to more expensive fuels. For them, clean transition measures (like electrification and efficiency upgrades) are essential for global competitiveness. Fuel consumption in transport will grow rapidly, heavily dependent on oil. This increases the vulnerability of mobility costs to international price shocks.

The shift from traditional biomass (firewood) to LPG and electricity raises challenges. LPG consists of imported liquefied natural gas and is transported in cylinders to households. This mass usage of LPG worsens traffic congestion in cities and exposes low-income households to global price fluctuations in the form of energy price hikes.

To address all of these concerns, one of the most important milestones is Bangladesh's decision to go nuclear. The ongoing Rooppur project is the primary part of this strategy. The notion is that nuclear power can provide a consistent supply, rather than solar or wind. Although nuclear power can be unpredictable, its ability to supply a huge amount of consistent energy could make a significant difference for industry. But there are huge financial costs, foreign loans, and also concerns about safety, while public confidence in the management of such initiatives remains limited.

It is clear that Bangladesh is chasing ambition while standing on fragile ground, and how the nuclear program plays out will shape not only the country's

Figure 1: Outlook of Clean Energy Supply



Source: IEPMP 2023

energy system but also its credibility in balancing growth with sustainability.

Bangladesh's energy strategy is described in the Integrated Energy and Power Master Plan. The plan shows a long-term path toward a low-carbon economy. It is guided by four principles: Safety, Energy Security, Economic Efficiency, and Environment. These ideas are often called the "S plus 3E" framework.

The plan aims for 40.2% of total installed generation capacity to come from clean energy by 2041. Currently, Bangladesh generates only about 4% of its electricity from clean sources. According to the IEPMP 2023, renewable energy is expected to provide just 8.9% of total power generation by 2041, while non-renewable clean energy sources are projected to account for 31.3%.

Against the power generation plan, the total clean energy supply in 2041 is projected (by IEPMP 2023) at 21.9 Mtoe, with 8.8 Mtoe (40.2% of total clean energy supply) from nuclear power and 13.1 Mtoe from other clean sources such as hydrogen, ammonia, CCS, modern biomass, solar, wind, and hydro (Figure 1). This distribution indicates that nuclear energy is expected to contribute significantly to the clean energy sector within the total primary energy supply.

Nuclear power is highlighted as one of the main pillars which will provide steady baseload capacity

and fill the gaps when renewable sources cannot supply enough. But the plan is criticized for being too cautious about renewables. The argument is also for its overreliance on untested new technology. The main concern is that the focus is more on the security of supply than on rapid decarbonization. This shows the balance Bangladesh is trying to achieve in its energy transition. Nuclear power is presented as a practical bridge, but the clean energy targets are still limited.

The Rooppur Nuclear Power Plant is Bangladesh's most ambitious infrastructure project. This power plant is projected to deliver 2400 megawatts of energy from two Russian-built VVER-1200 reactors. Russia finances about 90% of the cost, which is a significant fiscal responsibility for Bangladesh. The project has faced repeated delays, and shifting timelines continue to create concerns about increasing costs.

Positive criticisms argue that Rooppur represents more than just electricity: it is a leap into advanced technology and a way for the country to enter the global "nuclear club." But the regulatory and technical infrastructure is still evolving. Bangladesh is building institutional capacity even as the plant is being constructed. This double approach is far from ideal.

Safety remains a central concern for a country highly vulnerable to flooding and natural disasters. The IAEA conducted a pre-OSART mission in August 2025

and commended the operational staff's commitment. The government's nuclear development plan sets targets of 2400 MW by 2030, 4800 MW by 2041, and 7200 MW by 2050. Meeting these goals will require several units beyond the current Rooppur project. Meanwhile, the Rooppur Power Plant has been under construction since 2017 and remains non-operational even in late 2025. The project has been delayed by COVID-19, the Russia-Ukraine war, difficulties with foreign experts, late equipment deliveries, and unfinished transmission lines. The first unit's deadline has now been pushed to December 2026, with test runs unlikely before late 2025. In these circumstances, the plan for rapid multi-unit nuclear expansion looks overly optimistic.

Despite these challenges, Rooppur is pitched as the solution to continuous gas scarcity and unreliable renewables such as solar and wind. Yet this comes with long-term financial, technical, and environmental risks.

Nuclear power can give clean electricity, but the safety and environmental risks are still important. Rooppur is not near the coast, but Bangladesh often faces flooding, river erosion, and earthquakes that can damage big projects. The northern region where the plant is being built had small to moderate quakes before, and the Padma River nearby could also cause flooding or soil problems.

In a rush to modernize, the country is learning regulatory systems and risk management on the job, which isn't ideal for something as unforgiving as nuclear tech. If Rooppur is positioned as a flagship project, the challenge is not letting it become a liability that hinders all the growth it was supposed to enable.

Bangladesh's energy future will depend on whether it can balance nuclear power with renewables for the long term. In the power sector, the IEPMP 2023 projects that clean energy will account for around 165.3 TWh out of a total 411.1 TWh in 2041 and will reach the 40.2% target. Within this clean share, renewables remain modest, with solar, wind, hydro, biomass, and RE imports contributing about 8.9%, while nuclear contributes 8%, hydrogen 8%, and gas with CCS 7% among others (Table 1). This composition shows that the clean mix will rely more on nuclear and emerging low-carbon fuels than on

Table 1: Clean Energy Share of Power Generation

Source	Share (%)	TWh (approx.)
Nuclear	8	32.9
Hydrogen	8	32.9
Gas with CCS	7	28.8
Ammonia	1.8	7.4
Renewables (Solar, Wind, Hydro, Biomass, RE Imports)	8.9	36.6
Non-renewable Clean Energy Imports	6.5	26.7
Total	40.2%	165.3

Source: Calculated from IEPMP 2023

conventional renewables, reflecting Bangladesh's pragmatic approach to energy security. Regional cooperation could shape the trajectory as well. Bangladesh already imports electricity from India, and collaborations with Russia and China in nuclear and other infrastructure are still ongoing. But depending on neighbors also raises geopolitical risks. It is good to diversify country options to import energy, but not if it replaces one dependency with another.

The real test will be whether Bangladesh can build an energy system that is secure, affordable, and sustainable. That means getting the most out of nuclear without letting it crowd out cheaper and safer renewable opportunities.

Nuclear power may help Bangladesh meet its economic growth needs while aligning with climate goals, but it's not an all-in-one solution. The Rooppur project is a mega infrastructure project, but it is also a massive gamble on finance, safety, and foreign technology. If the government manages these risks carefully, nuclear power can give stability and buy time for renewables to scale. But if oversight stays weak and renewables stay sidelined, then the gamble could backfire. The real future of Bangladesh's energy is not just in reactors or solar parks but in building strong institutions that can plan and adapt. Rooppur is not only a plant; it is a test of whether Bangladesh can master the balancing act of energy transition.

Mohammad Iftekharul Islam, Research Associate at SANEM

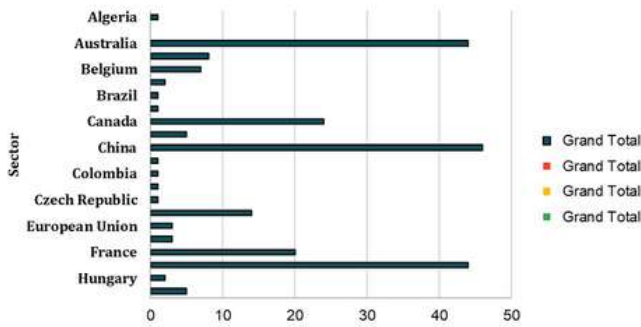
Email: contact.iftekhartne@gmail.com

Md. Tuhin Ahmed, Lecturer of Economics, MBSTU; Honorary Deputy Director at SANEM

Email: tuhin.ahmed@mbstu.ac.bd

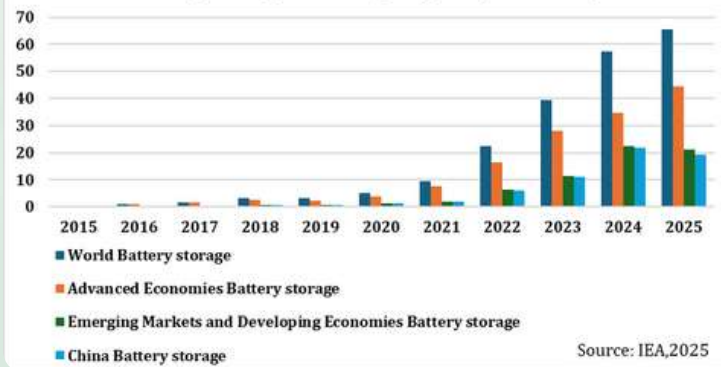
The 2025 Clean Energy Outlook: A Statistical Snapshot

Sector-wise Status of Technologies



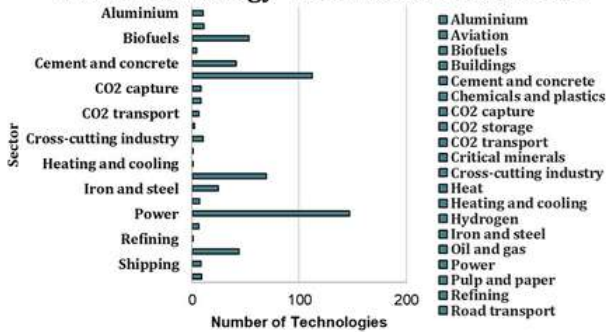
Source: IEA, 2025

Battery Storage Growth by Regions (2015-2025)



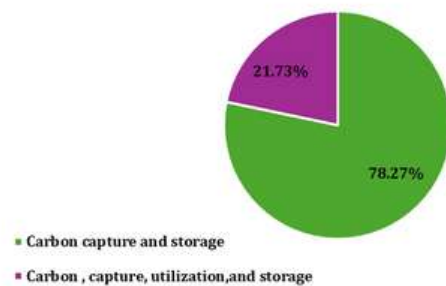
Source: IEA, 2025

Clean Technology-wise Most Active Sectors



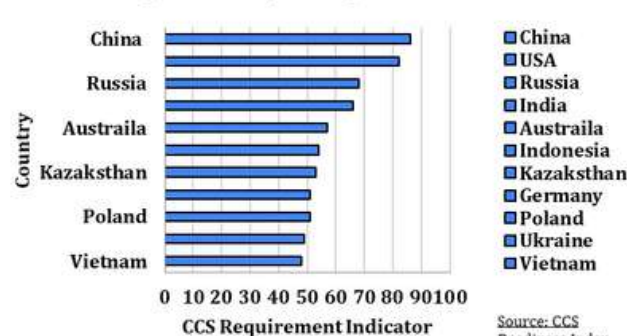
Source: IEA, 2025

Direct Air Capture Market, Share by Application (2024)



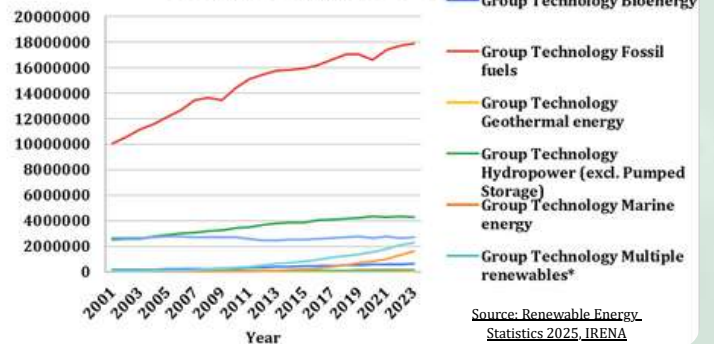
Source: Direct Air Capture Report, Grand View Research

Top Countries by CCS Requirement Indicator



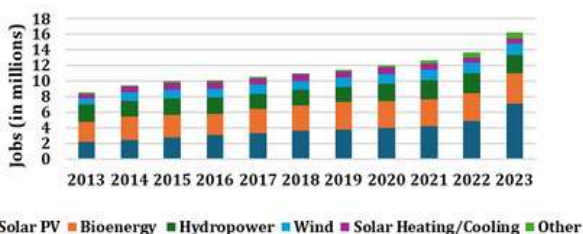
Source: CCS Readiness Index

Global Electricity Generation by Technology (2000-2023)



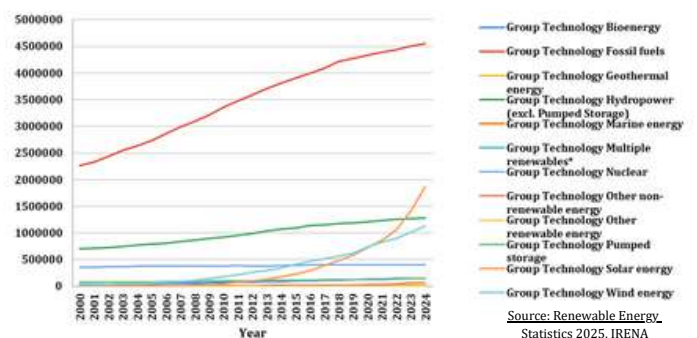
Source: Renewable Energy Statistics 2025, IRENA

Global Renewable Energy Employment by Technology 2013-2023



Source: IRENA

Global Installed Renewable Energy Capacity by Technology (2000-2023)



Source: Renewable Energy Statistics 2025, IRENA

SANEM Energy Outlook is a quarterly newsletter dedicated to disseminating SANEM's research on Bangladesh's transition to green and clean energy. SANEM, a non-profit research organization established in January 2007 in Dhaka and registered with the Registrar of Joint Stock Companies and Firms in Bangladesh, focuses on economic modeling and policy research specific to South Asia. It aims to deliver high-quality, objective research to support policymaking in the region. SANEM collaborates extensively with global, regional, and local think tanks, research organizations, universities, and individual researchers to enhance its research impact.

+88 02 58813075
<http://www.sanemnet.org>
 Flat K-5, House 1/B, Road 35, Gulshan 2
 Dhaka 1212, Bangladesh