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Pakistan's 2022 Mega-Flood a Grim Warning of Future Disasters

New climate projections show flood risks could multiply fivefold by century's end if emissions remain high

ER Report

Pakistan's devastating 2022 mega-flood, which claimed nearly 1,500 lives and caused over $30 billion in economic losses, may only be a glimpse of what lies ahead as climate change accelerates. A comprehensive study conducted by five researchers Arfan Arshad, Ali Mirchi, Cenlin He, Azeem Ali Shah and Amir Agha and appeared in Nature has found that the convergence of human-driven (anthropogenic) and climatic forces led to the catastrophic inundation in Sindh and Balochistan—an event that could become more frequent and severe under future warming scenarios.

Researchers warn that by the year 2099, extreme multi-day rainfall events like those of July and August 2022 could increase significantly in frequency and magnitude, especially under the high-emissions scenario known as SSP5-8.5. In that case, events currently considered "once-in-500-years" could occur multiple times in a single century.

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Pakistan's 2022 Mega-Flood a Grim Warning of Future Disasters

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From Drought to Deluge: A Dangerous Pattern

The 2022 flood was unusual not only for its scale but for the sequence of events leading up to it. After years of drought in southern Pakistan, pre-monsoon rainfall surged to 111% above the historical average (1951–2021), saturating soils in the Indus Basin. This was followed by an unprecedented 547% increase in monsoon rainfall, pushing already vulnerable systems past their breaking point.

Notably, extreme rain-on-snow events and heat-induced glacier melt in the upstream Hindu Kush–Himalayan ranges contributed to swollen rivers. At Sukkur Barrage, streamflow was recorded at 170% higher than the historical average—significantly intensifying flood risks downstream.

"Pakistan is already at the frontlines of climate change," the study notes, "but what we witnessed in 2022 is only a forewarning."

Future Projections: What's Coming

Scientists have used advanced modeling (ProNEVA) and remote sensing data to forecast future risks. Under a 2.0 °C global warming scenario (which is highly plausible this century), flood impacts in Pakistan could rise by over 500% compared to the 1981–2010 baseline. The country's glacier area is projected to shrink by 55%, raising the likelihood of flash floods driven by glacial lake outbursts and snowmelt-accelerated river flows.

Pakistan has already experienced 19 major flood disasters since 1950, but the pace and severity are expected to intensify drastically. Atmospheric rivers—moisture channels responsible for large-scale precipitation—are projected to become stronger and more frequent in South Asia, creating further instability.

Pakistan's Fragile Readiness

Despite being among the top ten nations most exposed to climate risks, Pakistan's investment in flood prevention infrastructure and urban drainage remains grossly insufficient. Urban centers like Karachi, Lahore, Islamabad, and Hyderabad suffer regular flash flooding during monsoon seasons due to poor planning, encroachments on floodplains, and weak governance.

With rising sea surface temperatures in the Arabian Sea and increasing moisture transport during the monsoon trough, southern Pakistan remains highly exposed. In 2022, Jacobabad recorded rainfall equivalent to a 728% increase over its average, while Larkana and Hyderabad saw increases of 934% and 532%, respectively.

The Kalat region recorded a 7-day rainfall event with a 425-year return period, now effectively shortened due to the impact of the 2022 data. Without urgent adaptation, what was once considered a rare disaster could become routine.

What Needs to Change?

Experts emphasize that risk forecasting, hydrological modeling, and infrastructure upgrades must be treated as national priorities. The government must scale up early warning systems, enforce zoning regulations to prevent floodplain encroachment, and invest in large-scale drainage and reservoir systems.

In parallel, climate diplomacy will play a critical role. Pakistan contributes less than 1% to global carbon emissions, yet bears an outsized share of the damage. Calls for climate financing, especially for adaptation and loss and damage, are growing louder.

A National Wake-Up Call

The 2022 floods were not just an environmental crisis—they were a humanitarian and economic emergency. Over 4 million hectares of farmland were submerged, livelihoods were destroyed, and a third of the country was left waterlogged for weeks.

If the world continues on its current emissions path, similar and even more devastating events could strike Pakistan every few years. With the Himalayan glaciers retreating, the Arabian Sea warming, and monsoons growing erratic, the need for climate-resilient infrastructure, smart urban planning, and regional collaboration has never been more urgent.■

Engineering Bazar

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Fast Cables Becomes First Pakistani Cable Manufacturer to Secure TAQA Certification

Fast Cables Limited, one of Pakistan's leading manufacturers of electrical cables and conductors, has achieved a significant milestone by becoming the first cable manufacturer in Pakistan to be certified as an approved vendor by the Abu Dhabi National Energy Company (TAQA).

In a notice to the Pakistan Stock Exchange (PSX), the company announced its official certification by TAQA, a global energy leader with a footprint in 11 countries across four continents. Known for delivering cutting-edge energy infrastructure and strategic energy projects, TAQA's endorsement places Fast Cables on the global energy map.

"This landmark certification is a testament to our commitment to quality, innovation, and adherence to international standards," the company stated. The recognition enhances Fast Cables' global credibility and affirms the reliability, performance, and competitiveness of its product portfolio.

As a certified vendor, Fast Cables is now uniquely positioned to support a wide range of TAQA's regional and international energy projects, offering high-performance cable solutions for essential industrial applications. The company emphasized its focus on delivering operational excellence and contributing to the energy sector's most demanding infrastructure initiatives worldwide.

About Fast Cables Limited

Fast Cables, headquartered in Lahore, Pakistan, is a prominent manufacturer of top-tier electrical cables and conductors. Known for its technological innovation, safety standards, and customer-centric approach, the company serves a wide spectrum of clients in power, infrastructure, industrial, and energy sectors—both locally and internationally.

Fast Cables continues to grow its footprint through advanced manufacturing, international certifications, and strategic partnerships aimed at powering Pakistan's infrastructure and energy development.

ENGINEERING REVIEW

Pakistan's Ambitious Digital Transformation Could Redefine Economic and Social Landscape: ADB

Pakistan's ambitious digital transformation agenda has the potential to redefine its economic and social trajectory, according to a recent report by the Asian Development Bank (ADB).

"By harnessing digital technologies, the government can drive sustainable economic growth, increase the tax-to-gross domestic product (GDP) ratio, grow

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OGDCL Achieves Major Boost in Oil Production at Rajian-05 Well

Oil and Gas Development Company Limited (OGDCL) has reported a significant milestone in its energy development efforts with the successful deployment of an Electrical Submersible Pump (ESP) at its Rajian-05 well.

The intervention has resulted in a remarkable improvement in production rates, marking a major step forward in the company's energy resource optimization strategy.

According to OGDCL, following a planned workover and the installation of the ESP, oil production at Rajian-05 has jumped from 820 barrels per day (BPD) to 3,100 BPD. In addition, gas production has doubled from 0.5 to 1.0 million standard cubic feet per day (MMSCFD).

The Rajian Field, situated in District Chakwal and operated solely by OGDCL under the Gujar Khan Exploration License, has been a key contributor to the company's portfolio since its discovery in August 1994. Two wells in the Rajian field had previously been equipped with ESPs, and the success of Rajian-05 further underscores OGDCL's commitment to enhancing output through data-driven reservoir development and modernization.

Company officials stated that this development is part of OGDCL's broader strategy to boost domestic energy production and ensure long-term sustainability and national energy security.

The information was disclosed in accordance with Section 96 of the Securities Act, 2015 and Clause 5.6.1(a) of the PSX Regulations for dissemination among market stakeholders. – ENGINEERING REVIEW

Zarea Launches Wholly Owned Subsidiary in UAE to Accelerate Global Expansion

In a significant move toward international expansion, Zarea Limited has announced the successful incorporation of its wholly owned subsidiary in the United Arab Emirates (UAE) under the name Zarea Commerce FZCO.

According to a notice submitted to the Pakistan Stock Exchange (PSX), the newly formed entity will be based in Dubai and serve as Zarea's regional headquarters. This strategic development is part of the company's long-term growth strategy aimed at strengthening its presence in international markets, accelerating export-led growth, and enhancing its role in technology-driven B2B trade.

"With the launch of our regional base in Dubai, Zarea is now well-positioned to expand its footprint globally and unlock new market opportunities," the company stated.

The move also underscores Zarea's commitment to digitization, export facilitation, and establishing deeper commercial links across borders. The company highlighted that this initiative aligns with its mission to support overseas operations, and it marks a milestone in Zarea's ambition to become a prominent player in global commerce.

Subsidiary Details:

Name: Zarea Commerce FZCO

Place of Incorporation: Dubai, United Arab Emirates

Ownership: 100% owned by Zarea Limited

The company's Board of Directors expressed confidence that the establishment of Zarea Commerce FZCO will accelerate Zarea's long-term value creation and deliver sustained benefits for shareholders. The company assured it will keep shareholders and the exchange informed of any future material developments as per regulatory guidelines. – ENGINEERING REVIEW

Mari Acquires Key Working Interests in KP, Balochistan, and Punjab Blocks from OPI

In a strategic move to expand its upstream petroleum portfolio, Mari Energies Limited has entered into farm-out agreements with Orient Petroleum Inc. (OPI) to acquire significant working interests in three exploration blocks across Pakistan.

According to the disclosure submitted to the Pakistan Stock Exchange, Mari Energies will acquire:

45% working interest and operatorship in the Marwat Block (Khyber Pakhtunkhwa)

45% working interest and operatorship in the Harnai South Block (Balochistan)

20% non-operating working interest in the Ratana D&P Lease (Punjab)

These acquisitions are subject to regulatory approvals, execution of deeds of assignment with the government, and other associated formalities.

The company stated that this move aligns with its broader strategy of expanding exploration and development activities across underexplored regions in Pakistan. Mari Energies emphasized that the transaction would contribute to the country's energy security and reinforce its commitment to responsible resource development.

The disclosure was made in accordance with Section 96 of the Securities Act, 2015, and Clause 5.6.1 of the PSX Regulations. – ENGINEERING REVIEW

Tahir Sultan Urges Establishment of Construction Bank to Boost Financial Capacity of Companies

In an interview with ER, Chief Executive, Firm Decon International says: The private sector companis' share is declining in Pakistan

Where Does the Construction Industry Stand in Pakistan?

The overall condition of the construction industry in Pakistan is not very promising at the moment, especially in the private sector. There are many challenges. The number of projects is not sufficient to match the capacity and efficiency of companies. This issue has persisted for the past three to four years. In fact, the situation did not improve after COVID-19, as many had hoped.

The private sector's share is also declining, as public sector companies—who should not compete directly—are now actively participating in bids and winning projects. This severely affects private contractors and reduces their opportunities.

Low Interest Rates and Stabilizing USD

Interest rate is only one of many factors impacting the industry. A whole series of issues creates hurdles. One of the major problems is the limited financial capacity of companies in the public sector bidding process, especially when it comes to requirements like security bonds. The conditions are so strict that many companies cannot meet them. As a result, the capacity of even technically capable public sector companies cannot be built.

If banks offer financial support with easier conditions, many of these companies could perform exceptionally well. Moreover, governments should release project payments on time so that companies are not forced to rely on bank financing. In such cases, interest rates do matter.

But the core issue remains the need to enhance the financial capacity of companies. The government should establish a Construction Bank and register credible construction companies. Many Pakistani companies have worked abroad and earned international recognition. Meanwhile, Indian companies have witnessed rapid growth in the Middle East and other markets, while very few Pakistani firms have secured projects there. The main reason behind this gap is financial limitations—both domestically and internationally.

Boom in KSA and Role of the Pakistani Government

Most Pakistani companies operating in Saudi Arabia are either EPC contractors or subcontractors to foreign or Indian firms. There is a lack of support and facilitation. In the 1980s, many Pakistani companies were active in the Middle East. Conditions were favorable, and Pakistanis had a credible image.

Now the situation is different—no easy terms, no financial facilitation, and no meaningful support from the federal government.

Construction Bank and Its Acceptance in Pakistan

The Pakistan Engineering Council (PEC), under the leadership of Engr. Jawed Salim Qureshi, worked extensively on the idea of establishing a construction bank and held discussions with the State Bank of Pakistan. I also gave some suggestions, and the council had good resources to support such an initiative. However, to move forward, they were asked to reach a certain paid-up capital requirement in order to get permission to set up the bank.

PEC's Role

The PEC must broaden its role beyond being just a regulatory body. It should not restrict itself to contractor registration only. It should focus on the welfare of engineers in Pakistan. The council must revise its bylaws to expand its scope. Employment of engineers is a critical issue. I believe around 50,000 engineers are currently unemployed.

I suggested that Pakistani diplomatic missions abroad should be tasked with helping engineers secure jobs in foreign countries. Additionally, PEC should prioritize research and development, as it has adequate resources to do so.

One of the key reasons for the growing unemployment among engineers is the mushroom growth of engineering universities across Pakistan.

Why Engineering Is Losing Its Appeal Among Youth

Naturally, when engineers cannot find jobs, they lose interest in the field. How are they supposed to survive in a state of unemployment? I've seen engineers working as waiters in hotels.

PEC must take immediate action against universities that do not meet the basic criteria of an engineering institution. Besides PEC, engineering societies must also step forward. We have formed a group called the Pakistan Society of Civil Engineers, which is run through our own resources. We organize monthly technical lectures for young engineers. I believe other branches of engineering should also establish similar groups.

We also aim to initiate research on construction codes, such as seismic standards and others. However, we need funding to engage scholars and conduct quality research.

Our Company

We started operations in 1992, offering soil investigation services. At that time, we were among the very few

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Moonis Abdullah Alvi Reappointed as CEO of K-Electric

The Board of Directors of K-Electric (KE) has reappointed Moonis Abdullah Alvi as the Chief Executive Officer (CEO) of the utility, effective July 30, 2025, for another term, reaffirming confidence in his leadership during a period marked by operational reforms, regulatory challenges, and evolving energy demands in Pakistan's largest city.

Alvi, who first assumed the role of CEO in July 2018, has overseen significant transformations at KE, including efforts to modernize the company's infrastructure, improve customer service, and navigate the complex regulatory and political landscape surrounding the privatized power utility.

Under his leadership, KE has:

- Invested in infrastructure upgrades including transmission enhancements and smart grid systems.
- Commissioned the 900 MW RLNG-based BQPS-III power plant, one of the largest private sector power projects in Pakistan.
- Advocated for multi-year tariff determination to ensure financial viability and long-term planning.

- Increased focus on digitization and customer outreach, including the expansion of mobile app services and online billing systems.

Despite these efforts, Alvi's tenure has not been without controversy or public scrutiny.

Challenges and Controversies

During his time as CEO, KE has faced:

- Frequent public criticism over power outages, particularly during peak summer months, with public complaints of unscheduled load-shedding in low-income areas.
- Regulatory hurdles, including disputes with NEPRA over tariff adjustments and delayed approvals of power purchase agreements.
- Delayed privatization progress due to bureaucratic and legal bottlenecks. KE's planned sale to Shanghai Electric Power has remained in limbo, with Mr. Alvi frequently calling on government stakeholders to resolve outstanding issues.

In 2022, severe flooding in Karachi exposed the city's fragile grid, leading to widespread outages. KE was criticized for delayed restoration efforts, although the company defended its actions citing safety protocols.

In 2023–2024, fuel cost fluctuations and gas shortages strained KE's supply chain, forcing temporary reliance on load-shedding in high-loss areas.

Despite these setbacks, industry observers credit Alvi for maintaining a measured and reform-focused leadership style, steering KE through one of the most volatile periods in Pakistan's energy sector.

Looking Ahead

With his reappointment, Alvi is expected to:

- Push forward renewable energy integration, particularly solar and wind, into KE's grid.
- Expand consumer-centric initiatives, with a focus on energy efficiency and net metering.
- Continue negotiations with the government for policy alignment and settlement of outstanding dues between KE, SSGC, and NTDC.
- Lead KE's digital transformation efforts to improve customer engagement and reduce line losses.

In a brief statement, KE's Board said:

"Mr. Alvi's vision and dedication have helped K-Electric navigate numerous challenges while maintaining a customer-first approach. We are confident that under his continued leadership, the company will further its mission of powering Karachi responsibly and reliably."

With more than 25 years of corporate experience, Moonis Abdullah Alvi previously served as KE's Chief Financial Officer before rising to the CEO position. He holds professional credentials in finance and has been associated with various industry platforms advocating energy sector reform. – ENGINEERING REVIEW

Beco Steel Marks Export Milestone with First Copper Ingot Shipment to Hong Kong

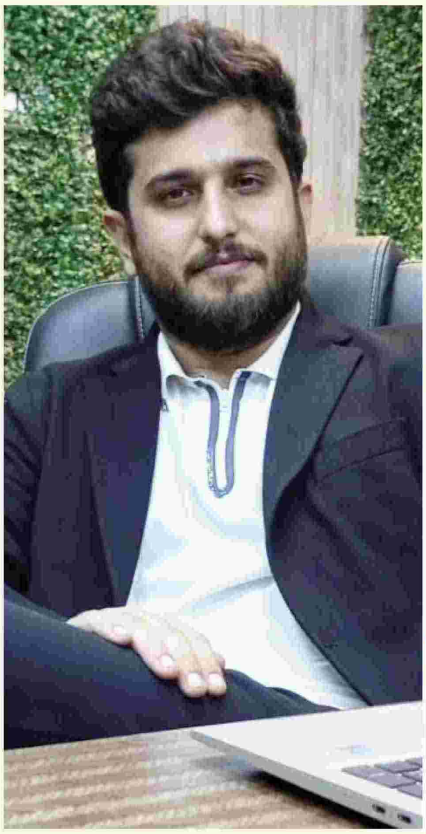
Beco Steel Limited has achieved a significant milestone in its business expansion by successfully completing its first export consignment of Copper Ingot to Hong Kong, China.

The consignment, produced from remeltable scrap of the company's raw material, signals the company's strategic move towards diversifying its revenue streams and entering new international markets.

According to a formal disclosure submitted to the Pakistan Stock Exchange (PSX), this shipment represents a promising new avenue for growth. The company views this development as a key step toward expanding its export business and enhancing shareholder value.

"This strategic step will support our objectives to enhance export revenues and generate greater value for our shareholders," stated the company in its communication to PSX, in accordance with Section 96 and 131 of the Securities Act, 2015 and Regulation 5.6.1 of the PSX Rule Book.

The company also assured the Exchange that it would keep stakeholders informed about any further material developments. – ENGINEERING REVIEW



Transforming Pakistan's Energy Landscape with Battery Storage Systems

Power Zone Partners with Chint to Bring Advanced ESS to Pakistan, says Abu Bakar Siddiqui, Director Power Zone in an interview with ER

Power World & Battery Energy Storage System

The generator generates, and the battery stores energy. The Battery Energy Storage System (BESS) has multiple applications and benefits. For example, from a Pakistani market perspective, it functions similarly to net metering, where excess power generated from solar is sent to a utility company and later drawn back, usually at night. In this way, the utility acts like a virtual battery.

However, in many rural areas of Pakistan, we lack access to the national grid, making net metering impossible. People use generators, but they are expensive for prolonged use. In such settings, battery energy storage systems become a reliable alternative. These systems can be charged either via the utility supply or through solar energy during daylight hours.

With this system, one can maximize energy storage. For instance, among the solutions we offer, you can install a 5 MW system that can sustain a 1 MW load for five hours. The storage capacity can be scaled up based on industry demand.

Lithium-ion batteries were already available globally, but the surge in electric vehicle (EV) demand has triggered extensive research and development in battery technology. Batteries are now recognized as the most critical component of such systems. There has been a race to make them cost-effective, and battery prices have significantly declined over the past five years.

This shift has transformed the energy calculations for industries. Many now consider battery-based systems a better investment than generators. They believe batteries are more cost-effective and free from the voltage drops, technical damages, and time losses commonly associated with generators.

Power Zone

Power Zone has been in the energy business for over two decades. We currently serve more than 10,000 customers. As a solutions provider, our clients place their trust in us—largely because of our commitment to after-sales service.

We have recently signed a partnership deal with Chint Power, becoming its official Energy Storage System (ESS) distributor in Pakistan. We now offer and market Chint's full range of solutions.

Chint is a leading Chinese company in battery technology. In fact, China currently dominates the global battery market. Nearly all major companies source their batteries from China due to its advanced technology and manufacturing scale.

Future Plans

We are closely aligned with the future of Pakistan's energy market. As people increasingly understand the cost-effectiveness of lithium-ion batteries, new applications are emerging in various scenarios.

For example, we offer a peak-sharing application. This allows users to buy electricity during off-peak hours and store it for use during peak hours—resulting in significant cost savings.

Pakistan's power infrastructure is weak in many regions, with frequent voltage fluctuations. In such areas, this system serves as a grid stabilizer, delivering a smooth and uninterrupted power supply even when the grid is unstable.

Moreover, in industrial settings where machines cannot be shut down and power outages occur, our system functions like a large-scale UPS, providing seamless power backup.

Most importantly, Pakistan has imported a massive capacity of solar panels. But utility companies cannot absorb all the surplus through net metering. In such a scenario, battery energy storage becomes essential—enabling consumers to store their own solar power rather than relying on utilities. Smart companies like Power Zone are stepping in to fill this crucial gap.■

Tahir Sultan

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companies working in this field. Between 1992 and 2003, we expanded into piling, tube wells, and various other types of testing. Later, we set up our own laboratory.

After 2003, we moved into transmission line projects and grid station design. We also conduct topographic surveys and are actively working in the solar energy sector. We are essentially a service provider in the infrastructure and energy domains.

Engineer-Owned Company: A Key Difference

It makes a big difference when the owner of the company is an engineer. In case of a new project, I address and resolve technical issues properly—no shortcuts. An engineer does not compromise on quality like a non-engineer might.

Anyone who visits our lab can see the standards and professionalism that reflect an engineer's commitment to engineering excellence.■

AGRI TECH

Pre-monsoon rains in Pakistan are crucial for agriculture, especially for the Kharif crops (summer crops). These rains, typically occurring from late June to early July, replenish water supplies and create favorable conditions for planting. However, extreme pre-monsoon rainfall can also pose risks, potentially leading to flooding and damaging crops.

Positive Impacts: Water Availability:

Pre-monsoon rains significantly contribute to filling reservoirs and water channels, which are vital for irrigation during the Kharif season.

Efficient Irrigation and Smart Water Use Highlighted as Key to Agri-Sector Resilience

Federal Minister for Water Resources, Mian Muhammad Mueen Wattoo, underscored the critical importance of adopting science-based solutions to address Pakistan's worsening water crisis, with a strong emphasis on improving water quality, supporting efficient irrigation systems, and promoting groundwater recharge in water-stressed regions.

Speaking during his visit to the headquarters of the Pakistan Council of Research in Water Resources (PCRWR) in Islamabad, the minister called for a national shift toward modern water management approaches. He particularly stressed the need to accelerate initiatives that promote water-saving technologies in agriculture, improve irrigation efficiency, and expand groundwater recharge interventions such as leaky dams and rainwater harvesting wells.

Established in 1964 and restructured under the Ministry of Water Resources in 2022, PCRWR is Pakistan's premier research body responsible for advancing water resource management, improving drinking water quality, and developing irrigation and conservation strategies based on scientific evidence.

During his detailed visit, the minister toured PCRWR's laboratories and technical units, reviewing the organization's current operations. While he expressed satisfaction with the commitment of the staff, he directed the management to boost institutional effectiveness and deliver measurable impact for the benefit of water-stressed communities.

"Water-related challenges are at the heart of Pakistan's development agenda," said Mian Muhammad Mueen Wattoo. "PCRWR must take a lead role in promoting practical water-saving solutions in the agricultural sector and ensure these interventions reach the field level."

He emphasized aligning PCRWR's work with key national frameworks, particularly the National Water Policy 2018 and Sustainable Development Goal 6 (SDG 6), which aims for universal access to safe and affordable drinking water. The minister also highlighted the urgency of expanding water quality monitoring, groundwater mapping, and research into irrigation pricing models to inform evidence-based policymaking.

The briefing included details of several forward-looking initiatives, notably an upcoming collaboration with South Korea to enhance PCRWR's digital infrastructure and research capabilities. Titled "Improving PCRWR Research Infrastructure and Enhancing Integrated Water Resources Management Capacity", the project aims to strengthen data-driven water planning and conservation strategies, aligned with SDG 6.

Notable upcoming efforts by PCRWR include:

- Expanding the National Water Quality Monitoring Program to 72 districts across Pakistan.
- Publishing the State of Water Quality in Pakistan annual report.
- Developing a National Water Budget and Water Scarcity Index.
- Conducting cost-benefit studies on irrigation water pricing models.
- Scaling up water-saving agricultural technologies.
- Implementing groundwater recharge projects, including leaky dams and rainwater harvesting wells, especially in drought-prone areas.

In his concluding remarks, Minister Wattoo reaffirmed the government's commitment to supporting science-based water management and strengthening research institutions like PCRWR. He urged the council to intensify its field outreach, technical innovation, and public service to address the mounting water challenges facing Pakistan. – ER Report

Pakistan and Kenya Explore Deeper Agricultural and Trade Cooperation

Federal Minister for National Food Security and Research, Rana Tanveer Hussain, held an important meeting with H.E. Lt. Gen. (Rtd.) Peter Mbogo Njiru, High Commissioner of Kenya to Pakistan to discuss ways to enhance bilateral cooperation, particularly in agriculture and trade.

Welcoming the High Commissioner, the Minister reaffirmed Pakistan's commitment to strengthening agricultural ties with Kenya. He noted that current bilateral trade stands at approximately USD 1 billion, with Pakistan exporting rice, cotton, and seeds, while importing tea and other commodities valued at around USD 350 million. Both sides recognized the potential to further diversify and expand trade, especially in agri-based products.

The High Commissioner expressed Kenya's keen interest in institutional collaboration and confirmed his upcoming visit to the Pakistan Agricultural Research Council (PARC) to explore opportunities for joint research and agricultural innovation. The Minister highlighted PARC's extensive network of 44 specialized research institutes across the country and emphasized Pakistan's willingness to partner in areas such as seed development, livestock, cotton production, and agri-mechanization.

A Memorandum of Understanding (MoU) on agricultural and trade cooperation is expected to be discussed and potentially finalized during the Pakistan-Kenya Joint Trade Committee (JTC) meeting, scheduled to be held in Islamabad from September 11 to 18, 2025. Minister Hussain noted that the JTC would serve as a key platform to institutionalize cooperation and finalize agreements aimed at expanding agricultural trade and knowledge exchange.

The Minister also acknowledged Kenya's growing interest in exporting products such as avocados, mangoes, flowers, and tea to Pakistan. He expressed particular interest in avocado imports, citing their quality and competitive pricing. He reiterated Pakistan's openness to diversifying its import basket, noting the complementarity between the two countries' agricultural strengths.

The High Commissioner highlighted the presence of 2,000 to 3,000 Pakistanis living in Kenya, contributing in sectors such as hospitality, banking, automobile trade, and development initiatives, including through organizations like the Aga Khan Foundation. Minister Hussain appreciated the diaspora's contributions and stressed the importance of people-to-people linkages in reinforcing bilateral ties.

It was also noted that Kenya maintains collaborative relations with Pakistani institutions such as the National Agriculture Foundation and the National Textile University, Faisalabad. The Minister underscored the need to build on these linkages to promote joint ventures, research partnerships, and technology transfer in areas including textiles, leather, and agricultural processing.

The High Commissioner expressed appreciation for Pakistan's longstanding support, particularly in defense training. Many Kenyan Army and Navy officers have received training at institutions such as the Pakistan Military Academy in Kakul and the Command and Staff College in Quetta. - PID

Thar Coal Block-1: Affected Villagers Accuse Companies of Land Grabs, Environmental Destruction, Broken Promises

By Ghazi Bajir

ISLAMKOT: Residents of Verwai village, located in the Thar Coal Block-1 area, have raised serious allegations against the companies operating in the region—Sino Sindh Resources Limited (SSRL) and Shanghai Electric.

The villagers accuse the companies of large-scale environmental destruction, land encroachment, broken promises, and harassment with the support of law enforcement.

According to locals, the companies have cut down thousands of century-old trees across hundreds of acres of green grazing land to carry out experimental plantations of Chinese grass, allegedly in the name of environmental sustainability. The affected community claims that valuable grazing land, essential for their livestock during the monsoon season, has been fenced off and taken over without adequate consultation or compensation.

"They've turned our lives into a nightmare," said Ameer Hasan Rahmon, a local resident. "Instead of fulfilling their commitments to rehabilitate us, they are conducting experiments daily. We've lost our homes, our graveyards, and now even the trees that have stood here for generations."

Residents report that despite signed agreements to protect graveyards and provide basic facilities, none of the commitments have been honored. Several Rahmon community families are still waiting for compensation for lands that now fall inside the coal project's boundaries. The village itself has been fenced in, with a single gate controlled by the company, leading locals to feel like prisoners in their own land.

Villagers further alleged that company officials, including SSRL Deputy CEO Abdul Qayoom Chaudhry, retired Brigadier Farrukh Naseem, and Area Manager Amanullah Junejo, have used police support to suppress protests, often threatening residents with terrorism charges to silence dissent.

"We speak for our rights, and we are labeled terrorists," said protester Zakaullah Rahmon. "Is this the price we pay for giving up our land for so-called national development?"

The people of Verwai staged a protest outside the Islamkot Press Club, demanding immediate intervention by the government and an end to what they call systematic exploitation under the guise of development. They questioned the companies' use of Corporate Social Responsibility (CSR) funds, alleging that millions have been spent on private experiments like Chinese grass cultivation, while nothing has been invested in local health, education, or infrastructure.

Officials from SSRL, when contacted, confirmed that an 80-acre Chinese grass plantation experiment is underway and claimed that if successful, seeds would be distributed among villagers for their benefit. However, villagers see this as another hollow promise.

Meanwhile, Mukhtiarkar Islamkot Anwar Hangorjo stated that partial compensation has been paid and that the rest will be disbursed soon. But locals remain skeptical, citing a long history of delays, deception, and unmet obligations.

As disputes over land, environment, and broken promises intensify, the villagers of Thar continue to demand justice, transparency, and meaningful rehabilitation—urging authorities to intervene before the situation spirals further.■

How Emerging Technologies are Shaping Sustainable Business?

Engr. Dr. Muhammad Nawaz Iqbal

The continuous development of technologies is transforming business strategies around sustainability, shifting to a paradigm of great importance of strategies focusing on proactive and innovation-driven policies of sustainability concern rather than the previous policies that emphasized the actuality of compliance with the environmental norms. The companies are not simply cutting down the carbon footprints, but are re-engineering the whole value chain with sustainability at the core of its vision.

Artificial Intelligence (AI), Internet of Things (IoT), blockchain and other technologies are playing the role of facilitators of intelligent and data-driven decision-making to make profitability tether to planetary well-being. The field of predictive sustainability now has Artificial Intelligence as a strong tool. In machine learning, predictive algorithms are used to determine the energy intake, streamline the supply chain, and minimize wastage using massive data streams. This proactive model assists companies to transform reactive environmental management into proactive.

As an example, AI is used in the agricultural sector to forecast crop diseases, water usage, and save resources and maximize the harvest with minimal harm to the environment. The Internet of Things has opened larger realms of real-time sustainability monitoring. There are chances to install sensors around the production facilities, transportation systems, or even in agricultural lands and collect real-time information about emissions, temperature, humidity, and other essential factors. Businesses are able to use this data to not only achieve regulatory compliance but they are able to model and test real-time different sustainability strategies, which helps to create more intelligent and quicker responses to environmental issues.

The blockchain technology is introducing transparency and visibility to the global supply chain. This is especially crucial to sustainability, where there has to be accountability throughout sourcing, production, and distribution. The stakeholders are in a position to trace the origin of the raw materials, evaluate the work conditions at source locations and confirm the source of ethics with blockchain. It not only reinforces ESG (Environmental, Social, Governance) structures, but also creates consumer confidence and confidence of investors.

Some advanced manufacturing processes, like 3D printing, minimize wastage because they also make the production of goods more specific and effective. Conventional manufacturing processes tend to cause high scrap. On the contrary, additive manufacturing is able to enable a leaner and greener process that enables just-in-time production, local manufacturing, and customization with little to no overproduction.

The new energy landscape is changing under the influence of energy storage and smart grid technologies that have a potent impact on businesses. Battery technology and AI-centered grid technology are countering the uncertainty in energy seen with renewable resources, such as solar and wind, by maintaining energy demand and supply. This gives businesses the more positive prospect of moving to renewables because they can keep rolling with operational stability and minimize the level of carbon emissions. Digital twins are helping companies to experiment sustainability scenarios and later make actual changes in reality.

Using computational representations to replicate the physical assets or systems, organizations can simulate their energy efficiency, assess the circular economies strategy and their supply chains resilience to the various environmental push and pull. The simulations minimize the chances of failure and enables proverbial tweaking of sustainability initiatives prior to being implemented. Technology is making the carbon accounting and carbon foot printing process more precise as well as automated. Integration of real-time logistics, production, and use of resources are now available through platforms to give the exact carbon footprints. It will enable organizations to benchmark their emissions, fix the targets of the reduction targets, and make their progress transparent. Regulatory compliance and Environmental, social, and governance reporting issues also become manageable using automated carbon accounting.

The redefinition of sustainable materials and processes can be through biotechnology and synthetic biology. Relating to engineered meat, to packaging being made out of biodegradable resources, biology and engineering are coming up with alternative choices to products of the past. As an example, biofuels can be produced with the help of genetically modified micro-organisms or the plastic products can be decomposed with them, thereby decreasing the need to use fossil fuels and mitigating the landfill issues.

Cloud computing is improving sustainable collaboration in business and across geographical boundaries. With cloud systems, the shared platform enables the sharing of data, resources and computing capabilities without energy-consuming infrastructure. Moreover, most of the significant cloud suppliers currently demonstrate a high level of interest in renewable energy and carbon neutrality, which enhances their favorable role in the area of sustainability. Edge computing works by transferring data closer to the source, and it decreases the energy burden of centralized data centers.

This is particularly beneficial when used in IoT in far-flung industrial works like in the mining industry or in farming that require decisions on local sustainability based on data with low latency. Edge devices are able to conduct in-time energy consumption analysis, water consumption, or efficiency of equipment, and immediately initiate corrective measures. Robotic Process Automation (RPA) is reducing environmental harm during administrative and working processes. RPA minimizes the use of paper, office, and travel through the mechanization of repetitive processes such as screening an invoice, procurement, or compliance checking. Such efficiency savings are indirect but they cumulatively result in high savings to the environment in the long run. The future application of quantum computing is to solve unruly sustainability questions where classical computers fail to provide answers effectively.

These consist of practice modeling of climate change situations, optimizing global logistics of minimum emissions, and creating new materials with reduced impact on the environment. Quantum breakthroughs have the potential to open the door to the solution of global sustainability problems and to do this, it is currently going through their early phases. The future of sustainability training and remote operations are Augmented Reality (AR) and Virtual Reality (VR). Now, businesses are able to run environmentally sensitive processes in a simulated environment without having to make any traveling or having to consume any physical resources. VR is also being employed to impart factory workers with the knowledge about how to retrospectively save energy and assist architects in modeling builders that are more responsible.■

آوازِ اقبال

اقبال کا ترانہ بانگِ درا ہے گویا
ہوتا ہے جادہ پیما پھر کارواں ہمارا

اے ہمالہ کوئی بازی گاہ ہے تو بھی، جسے
دست قدرت نے بنایا ہے عناصر کے لئے
ہائے کیا فرط طرب میں جھومتا جاتا ہے ابر
فیل بے زنجیر کی صورت اڑا جاتا ہے ابر

تیری عمر رفتہ کی اک آن ہے عہد کہن
وادیوں میں ہیں تیری کالی گھٹائیں خیمہ زن
چوٹیاں تیری ثریا سے ہیں سرگرم سخن
تو زمیں پر اور پہنائے فلک تیرا وطن
چشمہ دامن ترا آئینہ سیال ہے
دامن موج ہوا جس کے لئے رومال ہے
ابر کے ہاتھوں میں رہوار ہوا کے واسطے
تازیانہ دے دیا برق سر کوہسار نے

فرمانِ قائداعظمؒ

ایمان ، اتحاد ، تنظیم

اصول اور تفصیلات

گاندھی جی کہتے ہیں: "ہندوستان کو جیتے جی ٹکڑے ٹکڑے کیا جارہا ہے"
راج گوپال اچاریہ کہتے ہیں: "بچے کے ٹکڑے کیے جارہے ہیں"
قدرت نے پہلے ہی سے ہندوستان کو تقسیم کر رکھا ہے اور اس کے ٹکڑے ٹکڑے کر رکھے ہیں۔ ہندوستان کے نقشہ پر مسلم ہندوستان اور ہندو ہندوستان پہلے ہی سے موجود ہیں، نہ معلوم اس کے متعلق اتحاد و یلا کیوں کیا جاتا ہے۔ وہ ملک ہے کہاں جس کے ٹکڑے ٹکڑے کیے جائیں گے؟ اور وہ قوم کہاں ہے جس کی قومیت فنا کی جانے کو ہے؟
وہ طاقت جس کے قبضہ قدرت میں آج ہندوستان ہے، وہ انگریزوں کی طاقت ہے اور یہ جو ایک خیال دماغوں میں بیٹھ گیا ہے کہ ہندوستان ایک متحدہ ملک ہے اور اس کی اپنی حکومت ہے، وہ صرف اس وجہ سے ہے کہ انگریز اس سارے ملک پر حکمران ہیں۔
(مسلم لیگ کانفرنس، بمبئی۔ 26 مئی 1940ء)

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Pakistan's Ambitious Digital Transformation Could Redefine Economic and Social Landscape: ADB

Contd from page 3

exports, boost foreign direct investment, enhance social services, and improve governance — all while reducing costs and increasing efficiency," states the report "Pakistan's Digital Ecosystem: A Diagnostic Report."

The ADB emphasizes that Pakistan can bypass traditional stages of socioeconomic development by fully leveraging digital innovations. These technologies, it notes, are key to boosting GDP, expanding exports, attracting foreign investment, and improving service delivery — while simultaneously cutting public sector costs and enhancing operational efficiency.

According to the report, digital transformation holds the key for Pakistan to leap forward. Technologies such as mobile banking and digital payments could significantly improve financial inclusion and support entrepreneurship, particularly among underserved and rural populations.

The report also highlights the transformative potential of digitalization beyond the technology sector. In agriculture, manufacturing, and services, digital tools are enabling greater productivity and innovation. These shifts are not only creating new business opportunities but also generating employment across the wider economy.

Education and healthcare are also set for a digital overhaul. E-learning platforms and telemedicine services are seen as vital for bridging infrastructure gaps, especially in remote areas. Simultaneously, e-governance initiatives are being credited with improving transparency, efficiency, and citizen engagement.

Currently, Pakistan's digital sector contributes around 1.5% to national GDP. However, its indirect benefits across other sectors are substantial, making it a cornerstone of the country's sustainable development efforts.

Pakistan's digital landscape is rapidly evolving, driven by mobile technology, cloud-based systems, and automation. In a major legislative move, the Digital Nation Pakistan Act 2025 was enacted earlier this year, establishing the Pakistan Digital Authority to oversee national digital governance and innovation.

A key feature of the new legislation is the creation of the National Digital Commission (NDC) — chaired by the Prime Minister and the four provincial chief ministers.

The NDC will guide the strategic direction of Pakistan's digital transformation, ensuring alignment across federal and provincial efforts. Its mandate includes enhancing digital literacy, strengthening governance, and positioning Pakistan as a competitive player in the global digital economy.

The ADB's report sends a clear message: with effective implementation and sustained investment, Pakistan's digital transformation could be a game-changer — unlocking new opportunities for economic growth and social equity.— APP

BISMILLAH HIR REHMAN NIR RAHEEM

Surah Yaseen: Our Heart's Delight

By Muhammad Tariq Haq | www.eslpk.com

Yaseen—by the Qur'an's light,
Last Prophet, highly admired.

He came to guide not just his tribe,
But mankind, far and wide.

People before were lost in false pride;
Their chins held high, their necks were tied.

A barrier stood before their sight,
But faithful hearts received the light.

Recall the tale of three, inspired
Sent to a town that defied.

One faithful soul, with insight,
Came running to stand for what is right.

He cried, 'with Messengers, do not fight!'
He was honored as soon as he died.

In Paradise, he found delight,
While those who took his life faced their plight.

Behold His signs by day and night
Dead earth revived—a wondrous sight.

The darkened night, then bright daylight,
Ships that survive through mighty tides.

The Prophet warned of coming fright,
When graves will open, and life will revive.

The righteous will find more than the desired
Receiving SALAM from the most Glorified

But those who denied will be terrified;
Their hands and feet will testify.

No tongue can hide;
Their skin will speak the truth outright.

When someone is given long life,
His wisdom is often compromised.

See cattle we ride, their milk and hide;
From them, our needs are all satisfied.

Such is our Lord, His boundless might—
He says, 'Be,' and His plan is actualised.

The kingdom of all, in His hands, lies;
To Him, we return, the Most High.

Yaseen—hold it close, daily recite,
Let its guidance be your light.

پندرہ روزہ

انجینئرنگ ریویو

بانی: منعم الحسن بانی ایڈیٹر: ریاض الحسن

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سندھ کا پہلا اسپیشل ٹیکنالوجی زون 1500 ایکڑ اراضی پر کراچی ایجوکیشن سٹی میں قائم کیا جائیگا

8 سے زائد بڑے ملکی و غیر ملکی سرمایہ کاروں نے اس زون میں کام کرنے کیلیے گہری دلچسپی ظاہر کردی، سید قاسم نوید قمر

سلیکون ویلی کی طرز پر تعمیر کیا جائے گا، ٹیکنالوجی زون کے قیام کے لیے ماسٹر پلان پر ترقیاتی کام تیزی سے جاری ہے، معاون خصوصی

وزیر اعلیٰ سندھ کے معاون خصوصی برائے سرمایہ کاری و پبلک پرائیویٹ پارٹنر شپ سید قاسم نوید قمر نے سندھ کے عوام کو خوشخبری دیتے ہوئے کہا ہے کہ سندھ کا پہلا اسپیشل ٹیکنالوجی زون 1500 ایکٹر اراضی پر گڈاپ میں کراچی ایجوکیشن سٹی میں تعمیر کیے جانے کی منظوری حاصل کر لی گئی ہے اور اس سلسلے میں پاکستان اسپیشل ٹیکنالوجی زون اتھارٹی نے نوٹیفکیشن بھی جاری کر دیا ہے۔

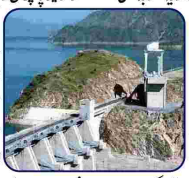
سید قاسم نوید قمر نے کہا کہ یہ اسپیشل ٹیکنالوجی زون ایکڈیمیا اور انڈسٹری کے الحاق کا بہترین سنگم ثابت ہوگا۔ اس اسپیشل ٹیکنالوجی زون کی اہمیت کا اندازہ اس بات سے لگایا جا سکتا ہے کہ 8 سے زائد بڑے ملکی و غیر ملکی سرمایہ کاروں نے اس زون میں کام کرنے کیلیے گہری دلچسپی ظاہر کر دی ہے۔ سید قاسم نوید قمر نے کہا کہ یہ اسپیشل ٹیکنالوجی زون سلیکون ویلی کی طرز پر تعمیر کیا جائے گا اور یہ زون اسمارٹ مینوفیکچرنگ کا ایک ایسا مرکز ہوگا جس میں آٹومیشن، ایڈوانس مینوفیکچرنگ، کلاؤڈ اینڈ ایج کمپیوٹنگ، سائبر سیکیورٹی، ہیلتھ ٹیکنالوجی، ایگری ٹیکنالوجی، بلاک چین، فائیو جی ہائپر اسپیڈ، کیلین انرجی اور دیگر جدید ترین ٹیکنالوجی کے ادارے قائم ہوں گے۔

انہوں نے کہا کہ اس اسپیشل ٹیکنالوجی زون سے صوبے میں جدید ترین ٹیکنالوجی اور تعلیم کو فروغ ملے گا اور نوجوانوں کے لیے تعلیم اور روزگار کے حصول کے وسیع مواقع پیدا ہوں گے۔ سید قاسم نوید قمر نے کہا کہ اسپیشل ٹیکنالوجی زون کے قیام کیلئے روڈ میپ پر مبنی ماسٹر پلان پر ترقیاتی کام تیزی سے جاری ہے۔■

تربیلا پانچواں توسیعی منصوبہ اگلے سال تک مکمل، معین وٹو

ورلڈ بینک 390 ملین ڈالر، ایشین انفرا اسٹرکچر انویسٹمنٹ بینک 300 ملین ڈالر دے رہا

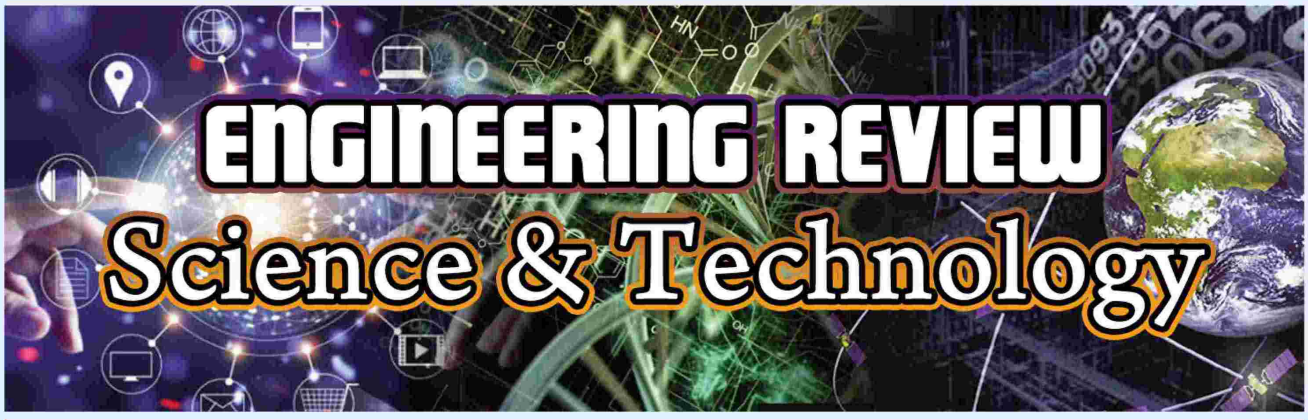
صلاحیت 1530 میگاواٹ، سرنگ نمبر 5 پر تعمیر جاری ہے، چیئرمین واپڈا کیساتھ دورہ



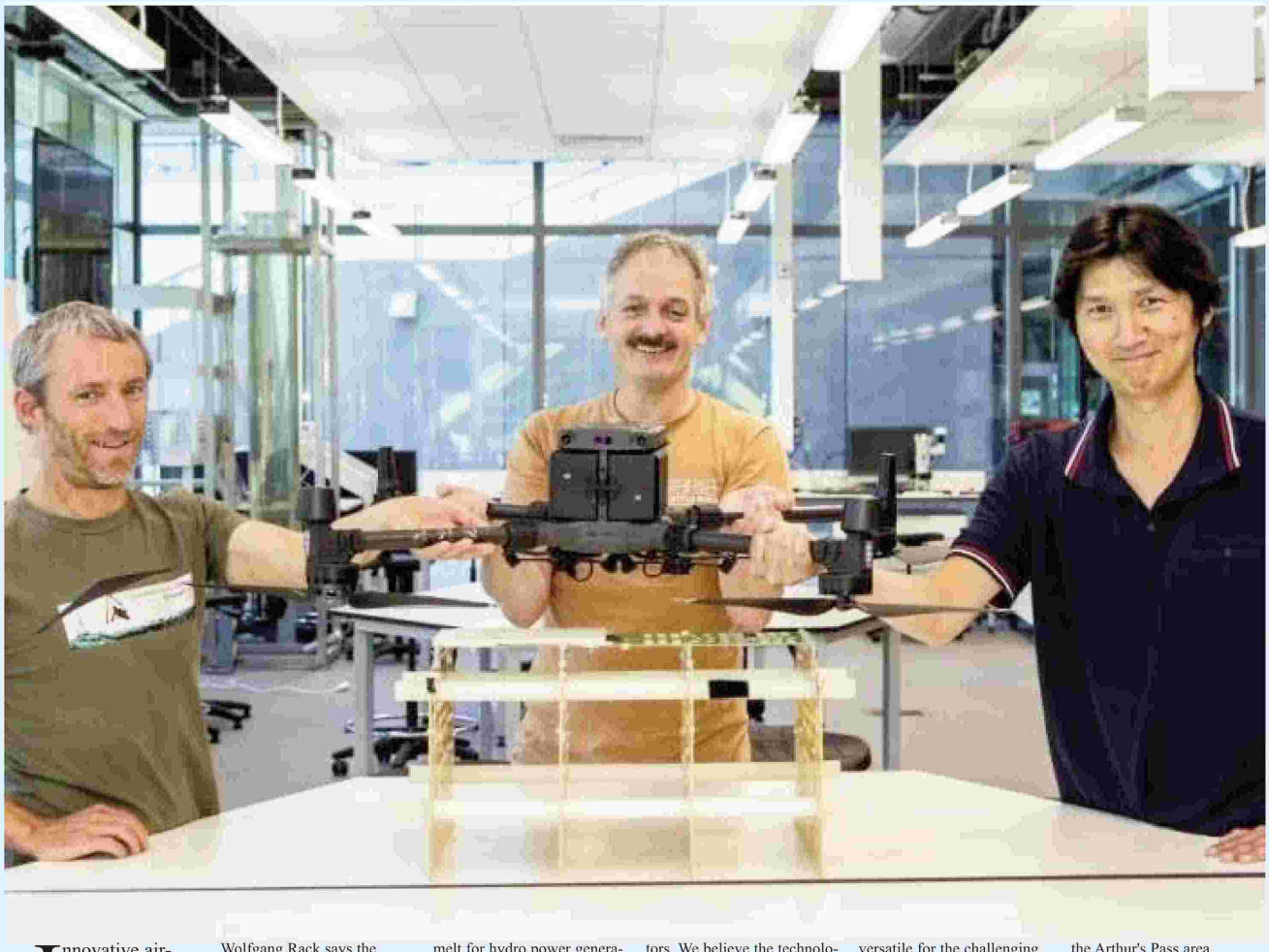
تربیلا ڈیم کے پانچویں توسیعی منصوبے سے بجلی کی پیداوار آئندہ سال متوقع، منصوبے کی مجموعی پیداواری صلاحیت 1530 میگاواٹ ہے۔ تکمیل کے بعد یہ منصوبہ نیشنل گرڈ کو ہر سال اوسطاً ایک ارب 34 کروڑ 70 لاکھ یونٹ کم لاگت پن بجلی فراہم کرے گا۔ توسیعی منصوبہ تربیلا ڈیم کی سرنگ نمبر 5 پر تعمیر جاری ہے۔

منصوبے کی تعمیر کیلیے ورلڈ بینک 390 ملین ڈالر جبکہ ایشین انفراسٹرکچر انویسٹمنٹ بنک 300 ملین ڈالر مہیا کر رہا ہے۔ وفاقی وزیر آبی وسائل معین احمد وٹو نے چیئرمین واپڈا نوید اصغر چوہدری اور دیگر حکام کے ہمراہ ٹی ایس 5 منصوبہ کا دورہ بھی کیا۔ اس موقع پر میڈیا سے گفتگو میں وفاقی وزیر معین وٹو کا کہنا تھا تربیلا پانچواں توسیعی منصوبہ 2026 تک مکمل ہو جائے گا۔ سستی بجلی کے ساتھ ساتھ لوڈ شیڈنگ میں بھی کمی آئے گی۔ ان منصوبوں سے پانی کی کمی کا مسئلہ بھی حل ہوگا۔

اس موقع پر چیئرمین واپڈا نوید اصغر چوہدری نے کہا ہے کہ منصوبہ کو جلد مکمل کر لیا جائے گا اور فی یونٹ قیمت پہلی پیداوار سے زیادہ ہو سکتی ہے جس کی وجہ بین الاقوامی کرنسی کا اتار چڑھاو ہے۔■



Snow radars on drones could help track climate change



Innovative airborne radars could soon be used to measure snow depth in New Zealand's alpine areas, helping to predict avalanche risk and monitoring the impacts of climate change.

The technology, which uses tiny but powerful snow radars mounted on drones or helicopters, is being developed by a University of Canterbury-led team.

University of Canterbury School for Earth and Environment Associate Professor Wolfgang Rack says the radars send signals to the ground which bounce back providing information on the thickness of snow beneath. This can be combined with satellite imagery, allowing the generation of 3D maps of snow load.

"The data provided by this technology, which is accurate to within just a few centimeters, could be used by ski fields, helping to predict avalanche risk and assess the safety of access roads in the mountains. It could also be used to assess snowfall changes on glaciers, find the safest areas to ski and provide information on snow melt for hydro power generation," Associate Professor Rack says.

A drone radar prototype has already been built by the team and tested over the past five years in shallow snow on Antarctic sea ice in a project funded by the Ministry for Business, Innovation and Employment (MBIE). Associate Professor Rack and his team are now working on adapting this technology so it's more suited to the New Zealand alpine environment.

"The world is losing snow at a record pace and we need snow data to manage these changes in our tourism, recreation and hydrology sectors. We believe the technology we have used in Antarctica can be adapted to provide highly accurate information on snow depth in alpine areas by using light but powerful radars that can be mounted on a drone or a helicopter," Associate Professor Rack says.

"It's more difficult in New Zealand because the snow is warmer here than in Antarctica and melt water in snow makes it more difficult to measure. But we're confident we can come up with a new radar antenna that has enough energy to transmit deeper into warmer snow making it more effective and versatile for the challenging New Zealand conditions."

Associate Professor Rack is working with Adrian Tan at Lincoln Agritech, Kelvin Barnsdale at RF Engineering Services, and Associate Professor Heather Purdie, Paul Bealing, and Dr. Adriel Kind, all from the University of Canterbury, on the project.

They are currently working on detailed plans for a prototype new antenna and adjustments to the software that controls the radar system. Associate Professor Rack says they hope to build the final design and fly it before the end of winter, with testing to be carried out in the Arthur's Pass area.

Associate Professor Rack says Christchurch's location as the gateway city for Antarctic research operations and as a center for alpine tourism makes the airborne radar research even more relevant.

"The business value of Antarctic operations in 2016 was estimated at $240 million a year for Christchurch and Canterbury and linked to 3700 jobs, and the value of Alpine tourism for Christchurch is probably similar or even higher. We hope that our project will be of benefit to both of these sectors." - TX

Disappearing electronics: Biodegradable fiber electronics offer solution to e-waste and textile pollution

The world produces over 92 million tons of textile waste annually, much of it made from synthetic materials that can linger for centuries.

Add to that the surge in wearable electronics—smartwatches, fitness trackers, sensor-laden garments—and the problem becomes two-fold.

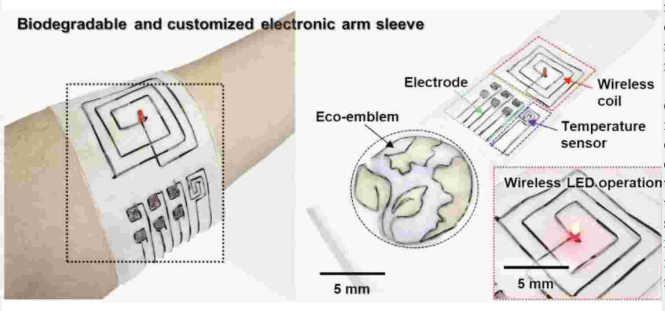
These e-textiles don't just include fabric, but also metal wires, plastic substrates, adhesives, and circuits that are nearly impossible to recycle. As electronics become more intimate, wearable, and disposable, the question becomes urgent: how do we design them to disappear when they're no longer needed?

A research team at Seoul National University has taken a significant step toward answering that question.

Led by Professor Seung-Kyun Kang and Dr. Jae-Young Bae, the team has developed a fully biodegradable, high-performance conductive fiber that can be seamlessly integrated into wearable electronics and naturally decompose after use. The study was published in npj Flexible Electronics.

Unlike conventional e-textiles that persist in landfills, this new fiber system maintains performance during use but vanishes in enzyme-rich or soil environments, leaving no harmful residues behind.

The team's innovation lies in combining tungsten microparticles with a biodegradable polymer known as poly(butylene adipate-co-terephthalate) (PBAT) to form a conductive fiber. This core is coated with a flexible, water-resistant polyanhydride (PBTPA) layer that enhances mechanical stability without compromising biodegradability.



The fiber achieves an impressive electrical conductivity of approximately 2,500 S/m, stretches up to 38% without failure, and endures over 20 laundry cycles and 5,000 bending events—performance metrics comparable to or better than many existing e-textile solutions.

Crucially, the fiber is compatible with dry-jet wet-spinning, a scalable process that enabled the team to produce lengths exceeding 10 meters in a continuous run.

To validate its real-world applicability, the fiber was integrated into a wearable smart sleeve featuring a temperature sensor, electromyography (EMG) electrodes, and a wireless power coil. The device operated reliably under dynamic movement and environmental stress.

After use, the entire system—including the embroidered eco-emblem—began to decompose when exposed to soil or enzymes, fully disintegrating within a few months.

"This is more than just a new material—it's a platform for sustainable electronics," said Professor Kang. "We've shown that you can have high-functioning wearable devices that don't become e-waste after their useful life ends."

Dr. Bae added, "The ability to design electronics that match the lifecycle of the application—and then gracefully disappear—opens up new possibilities in medical patches, smart uniforms, environmental sensors, and beyond. We're especially excited about the potential for use in disposable health care systems that don't contribute to long-term pollution."

The research represents a rare confluence of biodegradability, mechanical performance, and mass-manufacturability. Looking ahead, the team aims to expand the platform to incorporate fiber-based memory and logic components, moving toward fully integrated, transient electronic systems.

They are also exploring "triggerable" degradation mechanisms that respond to light, heat, or pH—enabling programmable lifespans for future devices. - TX

Low-cost method can remove CO_2 from air using cold temperatures and common materials

Researchers at Georgia Tech's School of Chemical and Biomolecular Engineering (ChBE) have developed a promising approach for removing carbon dioxide (CO_2) from the atmosphere to help mitigate global warming.

While promising technologies for direct air capture (DAC) have emerged over the past decade, high capital and energy costs have hindered DAC implementation.

However, in a new study published in Energy & Environmental Science, the research team demonstrated techniques for capturing CO_2 more efficiently and affordably using extremely cold air and widely available porous sorbent materials, expanding future deployment opportunities for DAC.

Harnessing already available energy

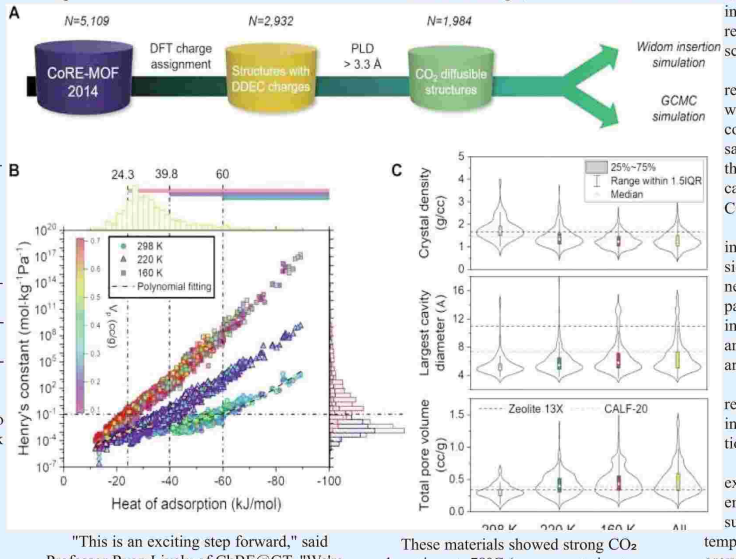
The research team—including members from Oak Ridge National Laboratory in Tennessee and Jeonbuk National University and Chonnam National University in South Korea—employed a method combining DAC with the regasification of liquefied natural gas (LNG), a common industrial process that produces extremely cold temperatures.

LNG, which is a natural gas cooled into a liquid for shipping, must be warmed back into a gas before use. That warming process often uses seawater as the source of the heat and essentially wastes the low temperature energy embodied in the liquified natural gas.

Instead, by using the cold energy from LNG to chill the air, Georgia Tech researchers created a superior environment for capturing CO_2 using materials known as "physisorbents," which are porous solids that soak up gases.

Most DAC systems in use today employ amine-based materials that chemically bind CO2 from the air, but they offer relatively limited pore space for capture, degrade over time, and require substantial energy to operate effectively. Physisorbents, however, offer longer lifespans and faster CO_2 uptake but often struggle in warm, humid conditions.

The research study showed that when air is cooled to near-cryogenic temperatures for DAC, almost all of the water vapor condenses out of the air. This enables physisorbents to achieve higher CO_2 capture performance without the need for expensive water-removal steps.



"This is an exciting step forward," said Professor Ryan Lively of ChBE@GT. "We're showing that you can capture carbon at low costs using existing infrastructure and safe, low-cost materials."

Cost and energy savings

The economic modeling conducted by Lively's team suggests that integrating this LNG-based approach into DAC could reduce the cost of capturing one metric ton of CO_2 to as low as $70, approximately a threefold decrease from current DAC methods, which often exceed $200 per ton.

Through simulations and experiments, the team identified Zeolite 13X and CALF-20 as leading physisorbents for this DAC process. Zeolite 13X is an inexpensive and durable desiccant material used in water treatment, while CALF-20 is a metal-organic framework (MOF) known for its stability and CO2 capture performance from flue gas, but not from air.

These materials showed strong CO_2 adsorption at -78°C (a representative temperature for the LNG-DAC system) with capacities approximately three times higher than those found in amine materials that operate at ambient conditions. They also released the captured and purified CO_2 with low energy input, making them attractive for practical use.

"Beyond their high CO2 capacities, both physisorbents exhibit critical characteristics such as low desorption enthalpy, cost efficiency, scalability, and long-term stability, all of which are essential for real-world applications," said lead author Seo-Yul Kim, a postdoctoral researcher in the Lively Lab.

Leveraging existing infrastructure

The study also addresses a key concern for DAC: location. Traditional systems are often best suited for dry, cool environments. But by leveraging existing LNG infrastructure, near-cryogenic DAC could be deployed in temperate and even humid coastal regions, greatly expanding the geographic scope of carbon removal.

"LNG regasification systems are currently an untapped source of cold energy, with terminals operating at a large scale in coastal areas around the world," Lively said. "By harnessing even just a portion of their cold energy, we could potentially capture over 100 million metric tons of CO_2 per year by 2050."

As governments and industries face increasing pressure to meet net-zero emissions goals, solutions like LNG-coupled near-cryogenic DAC offer a promising path forward. The next steps for the team include continued refinement of materials and system designs to ensure performance and durability at larger scales.

"This is an exciting example of how rethinking energy flows in our existing infrastructure can lead to low-cost reductions in carbon footprint," Lively said.

The study also demonstrated that an expanded range of materials could be employed for DAC. While only a small subset of materials can be used at ambient temperatures, the number that are viable grows substantially at near-cryogenic temperatures.

"Many physisorbents that were previously dismissed for DAC suddenly become viable when you drop the temperature," said Professor Matthew Realff, co-author of the study and professor at ChBE@GT. "This unlocks a whole new design space for carbon capture materials." - TX