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Water Ingress at Tarbela T5: Another Setback for a Project Already Under Pressure

The Tarbela 5th Extension Hydropower Project (T5), one of Pakistan's major ongoing energy infrastructure projects, suffered another setback on November 9, 2026, when a section of rock collapsed during excavation work, allowing a large volume of water to enter an under-construction tunnel and powerhouse area.

The incident raised fresh questions about construction safety, geological assessments, engineering supervision and the ability of the project's stakeholders to manage risks at a site that has already experienced a major construction failure, substantial cost escalation and delays.

Although the authorities managed to evacuate workers without any reported casualties, the incident has once again placed the performance and responsibilities of the project's three principal stakeholders — the Water and Power Development Authority (WAPDA), the consultants and the contractors — under scrutiny.

How the incident happened

According to WAPDA's initial statement, the incident occurred during excavation of the second bench of the connecting tunnel at the T5 construction site.



A weak section of rock mass collapsed, allowing water from the intake pit to enter the connecting tunnel and the under-construction powerhouse area.

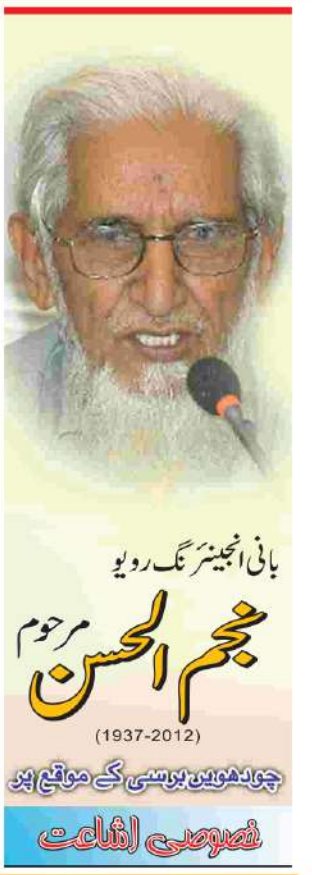
The sudden inflow prompted authorities to declare an emergency, suspend construction activities and immediately evacuate workers from the affected areas. Fortunately, all workers were moved to safety, and no injuries or loss of life were reported.

Initial reports also created confusion about whether the main tunnel of the T5 project had collapsed. WAPDA subsequently clarified that the incident did not involve the collapse of the main tunnel. Rather, it was a rock-mass failure during excavation of the connecting tunnel.

The authority maintained that the main Tarbela Dam and its critical structures were not under threat.

However, the incident was serious enough to require an immediate technical assessment involving WAPDA officials, consultants and contractors. The authorities needed to establish not only how water entered the construction area but also whether the incident had compromised the stability of surrounding rock formations or affected any completed sec-

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Keti Bandar to Become Maritime and Economic Hub as Sindh Approves Major PPP Projects



The Sindh government has approved a plan to develop Keti Bandar into an integrated maritime, industrial, logistics and energy hub, aiming to unlock the economic potential of the province's coastline and the Indus Delta through domestic and international private investment.

The project concept was approved at the 53rd meeting of the Public-Private Partnership (PPP) Policy Board, chaired by Chief Minister Syed Murad Ali Shah.

The proposed development will cover six major areas, including energy and petroleum infrastructure, industrial and logistics facilities, port and marine infrastructure, shipbuilding and marine services, community and tourism facilities, and digital security systems.

The envisaged facilities include oil terminals, storage tanks, pipelines, cargo yards, warehouses, industrial and export zones, deep-water berths, a modern fishing harbour, shipyard, dry docks and marine training facilities. The plan also includes tourism facilities, hotels, a marina, housing, healthcare and educational infrastructure, supported by modern vessel-monitoring, surveillance and emergency-response systems.

The board approved funding through the Project Development Facility (PDF) to engage transaction advisers for detailed feasibility studies and the preparation of a bankable PPP structure, paving the way for private-sector participation.

The meeting also approved a series of major initiatives across education, water supply, infrastructure, industrial development and technology.

750 schools to be outsourced

In a major education-sector decision, the board approved the second phase of outsourcing 750 schools under a 10-year service management arrangement.

The program covers 453 schools under the Sindh Secondary Education Improvement Project (SSEIP), 295 schools under the SELECT program and two English-medium People's Schools.

Education Management Organizations (EMOs) will operate the institutions under government-funded contracts. Their responsibilities will include teachers' salaries, non-teaching staff, operational expenses, uniforms, stationery and other essential services.

The schools have a combined capacity of 345,940 students, compared with current enrolment of 188,852.

Dhabeji SEZ to operate under joint venture

The board approved a revised transaction structure for the Dhabeji Special Economic Zone, replacing the earlier Build-Operate-Transfer model with a joint venture between the Sindh government, through the Sindh Economic Zones Management Company, and private investors.

Under the proposed arrangement, the government will contribute land and existing development works, while private partners will provide equity, technical expertise and investment.

The project covers approximately 1,171 acres of saleable land, including 1,071 acres for industrial activities and 100 acres for commercial use. Development is planned in two phases over 36 months.

Sukkur water and sewerage project approved

The board also approved the transaction structure for the Sukkur Water Supply and Sewerage Project, which aims to improve the city's water supply, distribution, sewerage and drainage systems.

The proposed interventions include treatment and pumping facilities, distribution networks, billing meters, an eight-million-gallon-per-day sewage treatment plant, drainage improvements and digitization.

Water demand in Sukkur is projected to increase from the current 30 million gallons per day to 32 million gallons in 2029 and 41 million gallons by 2048.

Major Karachi infrastructure initiatives

The meeting approved the concept of a Karachi Financial Centre to strengthen the city's position as a regional financial and investment hub. Funding was also approved for feasibility studies and transaction advisers.

For the Karachi Port-Qayumabad Corridor, a 16.5-kilometre, four-lane expressway connecting Shahrah-e-Bhutto with Karachi Port's East Wharf, the board considered a proposal to introduce an Infrastructure Real Estate Investment Trust structure.

The board also approved riverbank protection works for Shahrah-e-Bhutto Expressway, an additional loop and ramp at Memon Goth Interchange No. 5, and street lighting along designated sections.

A multi-level KDA Parking Plaza near Ziauddin Hospital in Clifton was also approved. Estimated to cost Rs1.61 billion, the facility will provide 96 car parking spaces and 160 motorcycle spaces. The board also approved assessing 41 additional KDA-owned sites for possible parking development.

Rs2 billion financing for Ghotki-Kandhkot Bridge

To maintain construction activities on the Ghotki-Kandhkot Bridge, the board ratified approval of Rs2 billion in bridge financing until commercial debt financing becomes available.

The project includes a 12.2-kilometre bridge across the Indus River and connecting approach roads.

The board also approved a draft mandate agreement with the International Finance Corporation (IFC) for a Partial Credit Guarantee facility of up to $100 million, equivalent to approximately Rs28.5 billion, to facilitate financing for selected infrastructure projects.

The meeting was attended by provincial ministers, senior government officials, members of the provincial assembly and representatives of relevant departments.

The chief minister directed the concerned departments to move the approved initiatives towards implementation through transparent competitive processes, sound project preparation and effective coordination. – ER Report

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VCs of Dawood, Sukkur IBA, Pro VC of Mehran to continue for another four years

The Sindh government has approved four-year extensions for the heads of three public-sector university administrations, allowing them to continue in their respective positions for another term.

They include Dr Samreen Hussain, Vice Chancellor of Dawood University of Engineering and Technology (DUET), Karachi; Prof Dr Asif Ahmed Shaikh, Vice Chancellor of Sukkur IBA University; and Prof Dr Aneel Kumar, Pro Vice Chancellor of Mehran University of Engineering and Technology (MUET), Jamshoro.



The decisions have been taken under the authority of the Sindh government, which exercises administrative control over public-sector universities in the province.

Sindh Chief Minister Syed Murad Ali Shah has approved a second four-year term for Dr Samreen Hussain as Vice Chancellor of Dawood University of Engineering and Technology.

Dr Samreen Hussain first assumed the position in February 2023. Reports on her extension have highlighted improvements in the university's financial management, academic standards, research activities and infrastructure during her tenure.

The university's financial position reportedly improved from a budget deficit to a surplus, while its pension and gratuity funds were also restored.

The provincial government has also approved a four-year extension for Prof Dr Asif Ahmed Shaikh, Vice Chancellor of Sukkur IBA University.

The development was reported on November 12, while Sukkur IBA University's own social media updates on November 16 also confirmed celebrations marking the extension of his

Contd on page 5

Water Ingress at Tarbela T5

Contd from page 1

tions of the project.

Damage assessment and restoration efforts

The immediate priority was to stop the water inflow, drain the affected areas and make the construction site safe.

WAPDA reported that water accumulated in the intake pit had been completely drained shortly after the incident. Dewatering operations at the under-construction powerhouse were also initiated using heavy-duty pumping equipment.

By November 13, restoration work had moved to the next stage, with engineers and construction workers engaged in round-the-clock efforts to plug the crater created by the rock collapse.

According to a report, the concrete pouring was underway to fill the affected opening and stabilize the area. Project officials indicated that the concrete work and powerhouse dewatering could take approximately one week, although this was an anticipated timeline rather than confirmation of completed restoration.

The initial assessment by WAPDA, consultants and contractors suggested that the main tunnel, powerhouse, tailrace culvert and switchyard had not sustained structural damage. Nevertheless, the full condition of the affected underground construction area required further technical verification.

The November 15 visit of Federal Minister for Water Resources Mian Muhammad Mueen Wattoo demonstrated that remedial work remained a priority. The minister reviewed the progress of restoration activities and directed the relevant teams to accelerate their work while maintaining safety and quality standards.

He also instructed the consultants, contractors and WAPDA project management to prepare contingency arrangements to minimize any potential delay in the project's completion.

The distinction between restoring the immediate work area and certifying the structural safety of the underground facilities is important. Draining water and filling a crater do not, by themselves, establish that the surrounding rock mass has regained its required stability.

An independent geological and engineering assessment will therefore be essential before normal construction activities can resume fully.

Who is responsible: WAPDA, consultants or contractors?

Perhaps the most important question arising from the incident concerns responsibility.

WAPDA Chairman Lieutenant General (Retd) Muhammad Saeed visited the project site on November 9 and 10 and ordered a departmental inquiry into the incident. He also directed the consultants to prepare a comprehensive report covering all aspects of the failure.

The Ministry of Water Resources had sought an initial assessment from WAPDA, which was submitted on November 10. Further technical reports and remedial measures were also being pursued.

However, no publicly available final inquiry finding had established responsibility for the November 9 incident so far.

It would therefore be premature to blame any one of the three stakeholders.

Nevertheless, the project's history makes the question of accountability particularly important.

In July 2026, a government-constituted inquiry committee investigating the August 2025 cofferdam collapse held WAPDA, the contractor and the consultant responsible for various contractual and technical failures.

The committee identified unauthorized post-contract design changes, inadequate technical scrutiny and failures in supervision and approval procedures among the reasons behind that earlier collapse.

The contractors involved included Power Construction Corporation of China, HEI and HEM, while the consultancy arrangements involved Mott MacDonald and associated partners. WAPDA was the employer.

That inquiry concerned the earlier cofferdam failure, not the November 2026 rock collapse. Its findings cannot automatically be applied to the latest incident. However, they raise legitimate questions about whether lessons from the previous failure were adequately incorporated into construction supervision, geological risk assessment and safety management.

The November inquiry must therefore establish whether the rock failure was an unforeseen geological event or whether weaknesses in site investigation, excavation methodology, rock support, drainage, monitoring or engineering supervision contributed to it.

It must also examine whether the contractor followed approved construction procedures, whether the consultant adequately monitored and reviewed the excavation work, and whether WAPDA exercised effective oversight as the project employer.

A project that cannot afford another setback

T5 has an installed generation capacity of 1,530 megawatts and is being developed with financial assistance from the World Bank and the Asian Infrastructure Investment Bank.

The project has already experienced substantial financial and scheduling difficulties. Following the earlier cofferdam collapse, its estimated cost rose from approximately Rs82 billion to Rs317 billion, while its completion target shifted from 2026 to June 2028.

The latest incident has consequently raised concerns about further delays and additional financial liabilities.

For Pakistan, the issue goes beyond one construction accident. T5 is intended to increase electricity generation capacity at a time when the country needs reliable and affordable energy.

The immediate emergency may have been contained, but the real test will be whether the authorities establish the technical cause, independently verify the safety of affected structures, fix responsibility where warranted and prevent a recurrence.

Without transparent findings and effective corrective measures, another expensive infrastructure project could remain vulnerable to the same cycle of construction setbacks, financial escalation and delayed public benefits. – ER Report

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Engr. Abbas Sajid Appointed ASHRAE RAL Regional Lecturer

Pakistani HVACR professional to contribute to technical knowledge-sharing and professional development across ASHRAE's Region-at-Large

Engr. Muhammad Abbas Sajid, a veteran Pakistani mechanical engineer and prominent figure in the heating, ventilation, air conditioning and refrigeration (HVACR) sector, has been appointed as an ASHRAE Region-at-Large (RAL) Regional Lecturer.

The ASHRAE Pakistan Chapter has formally welcomed his appointment, expressing confidence that his leadership experience and technical expertise will help advance the organization's mission across the Region-at-Large.

The appointment is significant for Pakistan's HVACR community, providing an experienced professional from the country an opportunity to contribute to the exchange of technical knowledge and professional development across ASHRAE's wider regional network. The RAL Regional Lecturer program brings experienced speakers to chapters and professional audiences to share technical expertise and industry knowledge.

Engr. Abbas Sajid is a graduate in Mechanical Engineering from NED University of Engineering and Technology. He founded Engineering



Services (Pvt.) Ltd. in 1984, building it into an established engineering services firm offering HVAC, mechanical, plumbing, firefighting and industrial engineering solutions.

A founding member of the ASHRAE Pakistan Chapter, Sajid has served as its president and held several leadership responsibilities within the international organization, including the position of Sub-Regional Chair. He has remained actively involved in promoting professional development, technical knowledge and collaboration between industry and academia.

His contributions have also received international recognition. In 2025, he received the ASHRAE Distinguished Service Award at the Society's Annual Conference in Phoenix, Arizona. NED University also honored his contributions by naming a boardroom in its Department of Mechanical Engineering after him.

The new appointment adds another responsibility to his longstanding association with ASHRAE and the HVACR profession. It is also an opportunity to strengthen Pakistan's participation in regional technical discussions on sustainable buildings, energy efficiency and the future of the built environment.

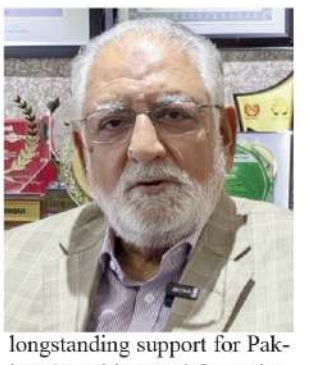
The ASHRAE Pakistan Chapter has wished him success in the new role, expressing the hope that his contributions will support the organization's efforts towards a more sustainable future. - ER

IAP Confers Rare Honorary Fellowship on Engineer Fahim Iqbal Siddiqui

The Institute of Architects Pakistan (IAP) has conferred its Honorary Fellowship on Engr. Fahim Iqbal Siddiqui, Chief Executive Officer of Fahim, Nanji & deSouza (Pvt.) Limited, in recognition of his more than four decades of contributions to building services engineering.

The distinction is particularly noteworthy as Siddiqui is an engineer being honored by the country's leading professional body for architects. It reflects the growing recognition of the role of building services engineering in the planning, design and functioning of modern buildings.

In an announcement issued on November 3, IAP described the recognition as a rare honor, acknowledging Siddiqui's exceptional contribution to the field and his



longstanding support for Pakistan's architectural fraternity.

Under IAP's constitution, Honorary Fellowship is a separate category from its regular Fellowship. It may be conferred on individuals who are not otherwise eligible for membership but whose contributions are considered significant to the promotion, development and appreciation of the architectural profession.

Siddiqui is a former president of the Pakistan HVACR Society, which also congratulated him on the distinction. In its congratulatory message, the society highlighted his longstanding contribution to building services engineering and described the recognition as a matter of pride for the organization.

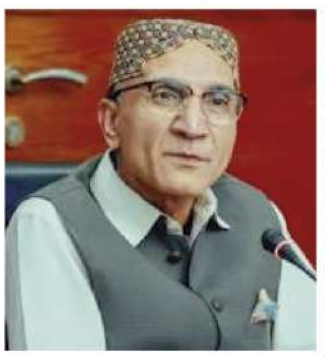
The honor underscores the close relationship between architecture and building services engineering, particularly in areas such as heating, ventilation, air conditioning and refrigeration (HVACR), which are essential to the performance, comfort, safety and energy efficiency of modern buildings. - ER

VCs of Dawood, Sukkur IBA

Contd from page 4

tenure.

Dr Asif Shaikh was appointed Vice Chancellor four years ago following the recommendation of a search committee headed by Dr Tariq Rafi. He is an NED University graduate.



Before the approval, the extension proposal was reportedly pending at the Chief Minister's House. Chief Minister Murad Ali Shah had also held a brief meeting with Dr Asif Shaikh to hear about his performance and achievements.

In another decision, the Sindh government has extended the tenure of Prof Dr Aneel Kumar as Pro Vice Chancellor of Mehran University of Engineering and Technology, Jamshoro, for another four years.

A wider debate over university leadership

The latest extensions come amid a broader discussion over the appointment and continuation of vice chancellors at public-sector universities in Sindh.

Several university heads have either received extensions or been considered for another term as their existing tenures approach completion.

Earlier, the Sindh government had also approved four-year extensions for Dr Ikramuddin Aijaz of Liaquat University of Medical and Health Sciences, Dr Zahid Hussain Khand of Aror University, and Dr Arbela Bhutto of Shaheed Allah Bux Soomro University. The tenure of Dr Nusrat Shah of Shaheed Mohtarma Benazir Bhutto Medical University, Larkana, had also reportedly been extended.

These decisions have brought renewed attention to the provincial government's policy for university appointments and extensions, particularly the role of performance evaluations, merit, institutional requirements and transparent selection procedures.

It is important to distinguish between the three latest decisions: Dr Samreen Hussain and Dr Asif Ahmed Shaikh are university vice chancellors, whereas Prof Dr Aneel Kumar is the Pro Vice Chancellor of Mehran University.

Separately, Mehran University's Vice Chancellor, Prof Dr Tauha Hussain Ali, was also granted a four-year extension in October 2026, effective February 2027, taking his tenure until February 2031.■



NED University Career Fair 2026

Leading Organizations under One Roof to Strengthen Industry–Academia Linkages

The Directorate of Industrial Liaison (DIL), of NED University of Engineering & Technology, successfully organized Career Fair 2026, bringing together leading national and international organizations, corporate representatives, and prospective employers under one roof to connect emerging talent with professional opportunities and strengthen industry–academia partnerships.

The full-day event provided an excellent platform for graduating students and fresh graduates of NED University to interact directly with industry representatives, explore employment opportunities, understand evolving market requirements, and establish valuable professional connections. The exhibition brought together employers from diverse sectors, including engineering, manufacturing, information technology, telecommunications, banking, energy, automotive, textiles, pharmaceuticals, logistics, and other industries.

Dr. Muhammad Tufail, Vice Chancellor, NED University, inaugurated the fair and visited the participating organizations. Speaking to Engineering Review, he stated that they have been consistently organizing a career fair for several years. A positive aspect—one that serves as a source of encouragement for us—is that the number of companies participating in the fair increases every year; this year, 66 companies have set up their stalls. The primary objective is to facilitate connections between the industry and our students.







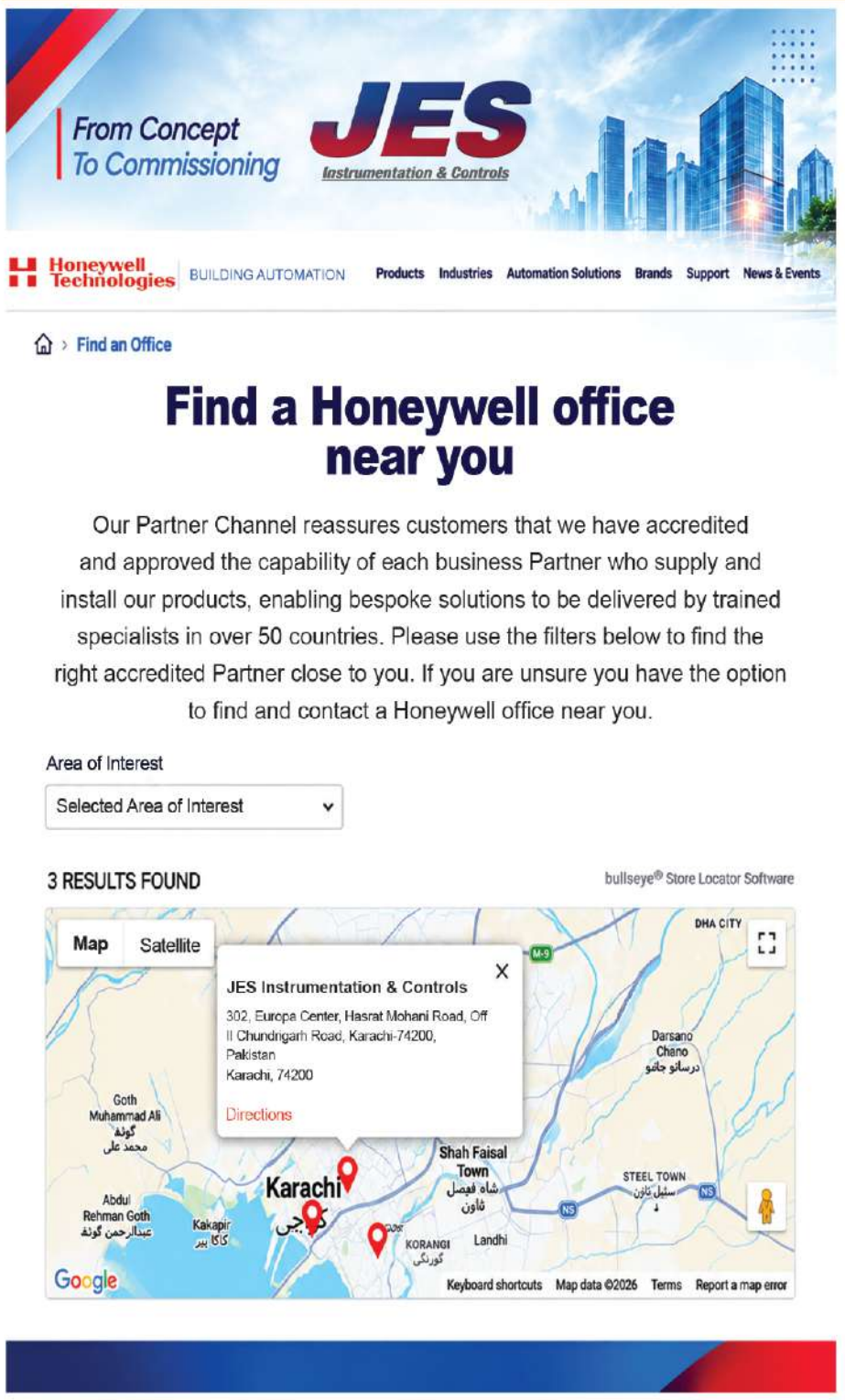
Most importantly, it provides the industry with an opportunity to interact directly with the students, allowing them to articulate the specific skills and competencies they look for in candidates. While we certainly provide students with an academic education—producing capable engineers and other degree holders—ultimately, it is the specific requirements of a given industry that hold real significance. While career fair offer various other benefits, the most significant aspect is the direct interaction between students and industry representatives. Through this, students gain insight into what the industry expects from them. This is the primary objective, and fortunately, it is progressing very well, with strong participation from the students.

Regarding the need to bridge the gap between industry and academia, Dr. Muhammad Ali Siddiqui, Director, DIL, stated that several factors contribute to this divide—some of which relate to the policies of the Government, such as the 'open import regime.' This area requires a review, with a focus on encouraging the production and use of locally manufactured goods in Pakistan. Furthermore, the cost of raw materials is extremely high, and the tax system also requires a thorough review. In reality, Pakistan possesses immense potential. At NED, work is underway on several projects tailored to the needs of the local industry—projects that exemplify industry-academia collaboration. Furthermore, in partnership with entities such as the NRPU, the Sindh HEC, the Pakistan Science Foundation, and others, efforts are being made to develop products for industries and provide solutions to various challenges they face. I believe the government needs to revisit its current policies to foster the growth of Pakistan's local industry and bridge the existing gap between the industrial and academic sectors.

The event witnessed participation through various sponsorship categories, including Mega, Platinum, Gold, and Silver Partners. Among the prominent sponsors and participating organizations were MAK Power International – HMF Consultants, Ismail Industries, ibex Global, Fine Daily, Tripack Films, DP World, DWP Group, International Industries Limited, and BYD.

A particularly encouraging aspect of the event was the commitment demonstrated by participating organizations, including representatives who travelled from Lahore and other cities to attend the fair and engage with NED University's graduating talent. Their participation reflected the growing confidence of the corporate sector in NED graduates and the importance of sustained engagement between universities and employers.

Career Fair 2026 stands as another significant step in NED University's ongoing commitment to bridging the gap between academia and industry, facilitating graduate employability, and fostering meaningful partnerships with the corporate sector.■





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13/13 international competencies covered

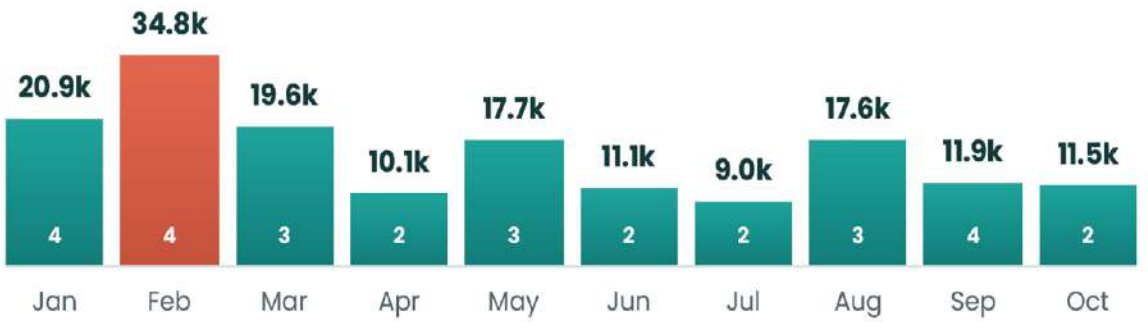
THE PEC CPD FRAMEWORK

Competency-led
Every webinar is mapped to an international (IEA) engineering competency before approval

Partnership-driven
Delivered in collaboration with HEIs, which host hands-on training in their labs

Evidence-based
Structured feedback on every major activity, used to improve each course

ONLINE CPD, MONTH BY MONTH PARTICIPANTS, JAN–OCT 2026



Number inside each bar = webinars that month. **Peak:** February, 34.8k. The last three webinars were the highest rated.

PEC'S OUTREACH

81% are **Registered Engineers**

68% have **10 years' experience or less**: CPD on the road to Professional Engineer

BALOCHISTAN CPD ACTION PLAN

Measure the gaps, then train for them

After the Chairman's Quetta commitment, PEC assessed engineers against the international benchmark, then trained **157 in person** and **10,329 online**, fully sponsored.



Today's learning, tomorrow's leadership.

FLASHBACK

FROM UNIFORM STANDARDS TO GLOBAL RECOGNITION

How PEC built Pakistan's standard for engineering education.



Anchorage, June 2017. Pakistan is declared a full signatory of the Washington Accord.

1976 Programmes at **7 universities and institutions** accredited

Early 1980s PEC begins **inspecting university examinations**

1985 **Regulations for Engineering Education**

1987 Accreditation Committee inspects **every engineering institution** in Pakistan

2007 First **Manual of Accreditation**

2010 Washington Accord provisional signatory; **Outcome-Based Education** introduced

2017 **Full signatory, 21 June:** PEC-accredited degrees recognised across Accord countries

535 accredited programmes in 151 institutions (2020)

30 engineering disciplines accredited (2020)

CARRYING THE STANDARD FORWARD

1987 Every institution inspected

2026 Benchmarked against 9 world universities

A gem of a person

Engr. Khalid Mirza | Engineering Consultants International Pvt. Ltd (ECIL)

The sudden demise of highly respected Syed Najam ul Hasan, Founder of a widely circulated fort-nightly Engineering Review, deeply grieved all his friends and those who came to know him during his professional ca-reer.

His tireless services aimed at promoting engineering profession and encouraging young engineers to play proactive role in development of Pakistan through hard work and adopting emerging technologies applicable in Pakistan.

He was a determined worker who kept ex-ploring all possibilities to ensure that his audi-ence remains up-to-date on critical issues confronting engineering fraternity in Pak-istan. On the fateful day, we lost not only a devoted journalist, but a relentless preacher of optimism and a fine human being.

My recollections of Syed Najam ul Hasan are multi-dimensional. To me he was much more than merely a dedicated journalist. My association with him dates back to mid eighties. His hu-mane disposition brimming with positive demeanor and ever smiling face remained a catalyst in strengthening an association of trust and mutual respect.



He was a true patriot and a passionate advocate of 'Ideology of Pakistan'. Despite prevail-ing frustrating political and economic constraints, he remained optimistic and placed his unconditional trust in young professionals believing that they will rejuvenate and resurrect the very concept and ideology of Pakistan in its true sense and spirits.

While his belief and trust in the young is yet to be fully realized, one may look at Syed Najam ul Hasan as a beacon and source of inspiration for truly believing in Pakistan and its po-tentially bright future. And we must work collectively to reach the said destination.

His initiatives on providing scholarship to deserving engineering students and idea of initiating annual awards for inspiring young professionals have indeed gained recognition from all quarters. These ideas require continued support from engineering professionals who would like to witness improvement in Pakistan's engineering industry. He was a committed journalist who strived throughout his life to remain on the right side of ethos defining profes-sional ethics and morality.

As a devout believer of Islamic philosophy in letter and spirit, he always sided with liberal forces supporting healthy discussion, progress and new ideas that could benefit the country. He was a true friend who stood by his friends in the time of their need providing all the moral sup-port that he could. A gem of a person, he will always remain in hearts and minds of everyone who he interacted with.

We humbly pray to Allah Almighty for His forgiveness and blessings for the departed soul and to confer strength on the bereaved family members, friends and well wishers in overcom-ing the shock of the tragedy of an irredeemable loss (Amen).

Here Engr. Jafri also greatly appreciated ER doing part of the reporting in Urdu. This is ER's unique feature and shows Najam marhoom's love for the national language. He stated. "I really like Engineering Review, not only because of its Urdu pages but also because of high quality re-alistic reports, whose primary objective is very clearly bringing forth the achievements and good works of Pakistani engineers, specially the younger generation.

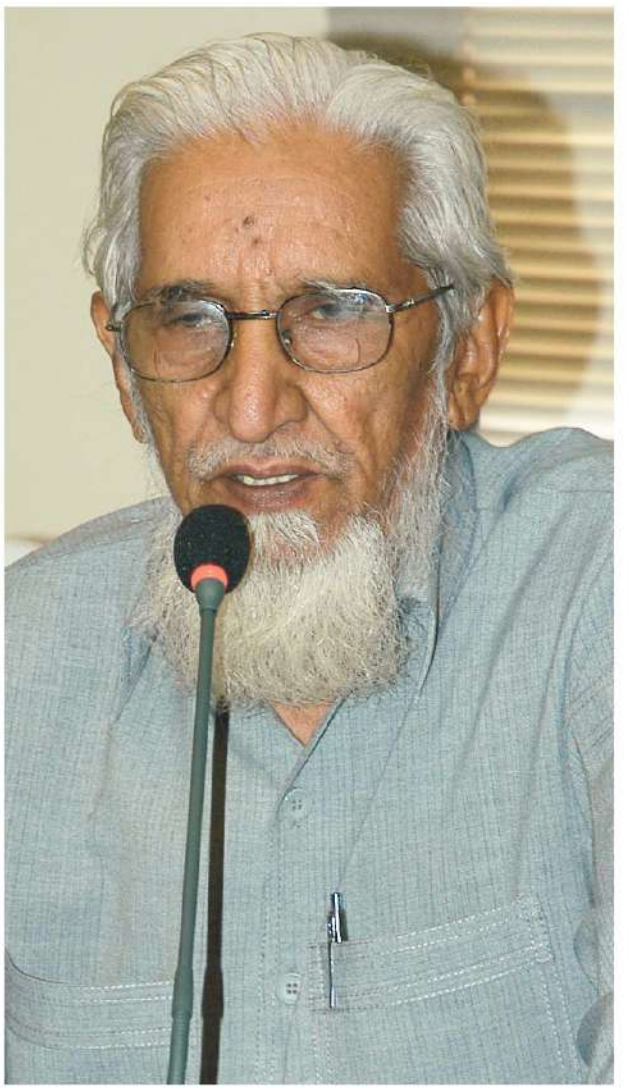
I also appreciate the fact that ER does not 'weep over' poor conduct or minor negative mat-ters. ER reports (big) failures only with the objective of helping correct things and avoiding them in future. This is a positive mind set which is rather rare in the community of news re-porters', added Engr. Jafri.

Another very good initiative taken by Najam marhoom was to launch the Young Engineer-ing Leaders Award in 2011. This was his way of encouraging young engineers to score big in positive ways. The Award, I hope, will be kept alive by those who succeed Najam marhoom; no harm if some variations are included.

I greatly appreciate all these plus points but I regret two areas where ER did not come up to its full potential. One, in these 37 years, ER's print order should have reached at least 20,000 copies, but it has not gone beyond its original figure of 5,000. Two, ER should by now have be-come an international paper. Unfortunately ER did not move an inch towards these objectives.

As to my personal links with Najam marhoom, I greatly loved him because of his sincerity of purpose, forthright and futuristic approach. He was honest to the core and a spade was a spade and nothing else in his vocabulary. He showed by example that even then he could stay afloat and moving.

I have been told by many that he gave excellent training to young employees of his company. He was lucky to have a team which always kept high quality in focus. And working under Najam has kept the venture alive despite difficult era of national economy, concluded Jafri ■



Najam: A Man of Principles

Engr. Naveed Ansari | Systek (Pvt) Ltd.



I did not have many contacts with Mr. Najam ul Hassan, founder Publisher and Managing Editor of Engineering Review but it were two detailed meetings where I came to know him fully. I was impressed with his mind set. He was positive and a man of principals in whatever he planned to do. His raising of 'Young Engineering Leaders Award' was the thing that impressed me most.

This is how Engr. Naveed Ansari head of Systek Pvt Ltd, Karachi began to describe what he thought of Najam Sahib marhoom. Engr. Ansari was till recently Honorary Sec-retary of Karachi chapter of the Institution of Electrical & Electronics Engineers, Pak-istan (IEEEP). He quit the post in the tenure beginning mid 2012. IEEEP K was very active during his days.

My second detailed meeting was a couple of months before he departed. Engr. Ansari said this speaking to Engineering Review to complement Najam marhoom for his efforts via ER. He was dedicated to the cause of promoting quality and ingenuity in Pak engineers' work. He always highlighted good work and ignored blunders though they are nor-mally 'big news' for mass of newspapers.

He ignored negative aspects of engineers' work as these reports paint a bleak picture of engineers' skills and work pattern. This fully reflected his mind set that Pak engineers and Pakistan as a whole must never be painted negative.

Engineering Review's coverage of IEEEP K's Multi Topic Symposium was very good and IEEEP members used to like it fully. But it was Young Engineering Leaders Award that impressed me most. This fully reflected his desire to highlight the good work of Pak engineers and create a positive picture of our national capabilities. I pray that may Allah give the next ER team the will and resources to continue it.■

جہد مسلسل کی تصویر اور اپنے خدا سے پُر امید

نجم الحسن مرحوم کی سوانح حیات "میری داستانِ حیات" سے اقتباس

شروع 1975 میں مجھے انجینئرنگ رویو کی اشاعت شروع کرنے کے لئے حکومتی محکمہ میں درخواست داخل کرنا تھی۔ اس کے لئے میرے بینک اکاؤنٹ میں پانچ ہزار روپیہ ہونا ضروری تھا۔ کسی سے قرض لے کر اپنے اکاؤنٹ میں یہ رقم جمع کرا کے بینک بیلنس سرٹیفکیٹ حاصل کیا۔ دوسرے دن یہ رقم واپس کر دی۔ میرا مالی استحکام سچا بھی تھا اور جھوٹا بھی۔

اچھا دفتر کیسے مل گیا

جب انجینئرنگ رویو نکالنے کا اجازت نامہ مل گیا، تو دفتر کی تلاش شروع کی۔ اچھے علاقوں اور اچھی عمارتوں میں دفتر بہت مہنگے تھے، ایڈوانس بھی زیادہ اور کرایہ بھی زیادہ۔ یہاں ناکامی کے بعد دوسرے اور تیسرے مرحلہ میں کم تر علاقوں میں دفتر تلاش کرنا شروع کیا۔ گھڑیالی بلڈنگ صدر، ناظم آباد، برنس روڈ اور اس طرح کے اور علاقوں میں بھی قسمت آزمائی کی۔ یہ بھی سوچا کہ فردوس کالونی میں گھر پر ہی دفتر بنا لیا جائے۔ تجربہ کار لوگوں نے منع کیا کہ اس میں بہت سی خرابیاں مضمر ہیں۔

دفتر کی تلاش جاری تھی اور ساتھ ہی بددلی اور مایوسی بھی بڑھ رہی تھی۔ اُس وقت میں میڈیکل نیوز میں کام کرتا تھا۔ اس رسالہ کا دفتر گورنر ہاؤس کے سامنے واقع پاکستان انسٹی ٹیوٹ آف انٹرنیشنل افیئرز بلڈنگ میں تھا۔ دفتر کی تلاش میں جب میں اس ادارہ کے سیکریٹری سے ملا تو معلوم ہوا کہ میڈیکل نیوز کے سامنے والا کمرہ کئی ماہ سے بند ہے۔ میں اس کے مالک ظہیر صاحب سے معلوم کروں کہ وہ اپنا دفتر مجھے دیں گے یا نہیں۔ ظہیر صاحب کا کرایہ واجب الادا ہے جو میں ادا کروں۔ دوسری شرط یہ تھی کہ میں ٹیلی فون کے سابقہ بل بھی ادا کروں اور فون بحال کرا لوں۔ میں نے یہ دونوں شرطیں پوری کر دیں۔ اس طرح



پتہ؟ وہ سیکریٹری کو معلوم نہیں تھا۔ اس کو کہتے ہیں پیاسے کے سامنے پانی تو ہے مگر وہ پی نہیں سکتا۔

میں نے ظہیر صاحب کو خط لکھا کہ میں ان کا دفتر لینا چاہتا ہوں۔ یہ خط میں نے دروازہ کے نیچے سے اندر دھکیل دیا۔ میں میڈیکل نیوز میں اپنی نشست پر آ کر بیٹھا ہی تھا کہ سامنے والا کمرہ کھلنے کی آواز آئی۔ میں شوق اور بے چینی سے آیا تو دیکھا کہ ایک صاحب میرا خط پڑھ رہے ہیں۔ معلوم ہوا کہ وہی ظہیر صاحب ہیں۔ ظہیر صاحب دفتر چھوڑنے کے موڈ میں نہیں تھے۔ البتہ ان کی پیش کش تھی کہ میں ایک میز کرسی لے آؤں اور اپنا کام شروع کر دوں۔ ان کی دو شرائط تھیں: اول یہ کہ اس کمرہ پر نو ماہ کا نہایت سستے داموں اچھی عمارت اور شاندار محل وقوع میں نہ صرف دفتر مل گیا بلکہ ایک الماری سمیت دفتر کا سارا فرنیچر ظہیر صاحب نے میری تحویل میں دے دیا۔ صرف یہ پابندی تھی کہ کوئی شخص اُن کی میز کرسی استعمال نہیں کرے گا۔

ظہیر صاحب کی ہر چیز نفاست اور قرینہ کی آئینہ دار تھی۔ وہ نہایت صاف لباس اور چمکدار جوتے پہنتے تھے۔ کسی چیز میں بے ترتیبی میل کچیل یا گرد و غبار انہیں برداشت نہ تھی۔ مشرقی پاکستان کی علیحدگی تک ظہیر صاحب فوج کو کاغذ، لفافے اور سٹیشنری کی دیگر اشیا سپلائی کرتے تھے۔ بڑے بڑے آرڈر ملتے تھے، آمدنی اتنی معقول تھی کہ افسروں کو فریج اور ایرکنڈیشنر تحفہ میں دے سکتے تھے۔

1971 میں مشرقی پاکستان سے کاغذ آنا بند ہو گیا۔ دیگر ذرائع سے آنے والا کاغذ بہت مہنگا تھا۔ واقف افسروں کے تبادلے ہو گئے جس کی وجہ سے کم سپلائی دے کر گنتی پورا کرانی ممکن نہ رہی۔ ان حالات نے ظہیر صاحب کو بالکل برباد کر دیا تھا۔ چند سال بعد انہوں نے اپنا دفتر ہمیں تیس ہزار میں فروخت کر دیا۔ اور نو سال اس عمارت میں گزار کر تیس یا چالیس ہزار میں وہ دفتر پڑوس میں واقع روبی رائس کو فروخت کر دیا۔

پی آئی آئی اے بلڈنگ میں ہمیں دفتر کیوں مل گیا۔ دلیل اور منطق سے اس کا کوئی جواب نہیں۔ بس اللہ کی مہربانی تھی کہ ڈھونڈے والوں کو خدا بھی مل جاتا ہے۔

نیا اور بڑا دفتر، اللہ کی نئی اور بڑی مہربانی



اس عمارت میں نو سال گزارنے کے بعد دفتر ہمیں چھوٹا محسوس ہونے لگا۔ نئے، بڑے دفتر کے حصول میں رقم کی کمی ایک بار پھر اس طرح رکاوٹ تھی جس طرح 1975 میں تھی۔ لیکن یہاں مجھے ایسٹرن بلاک کے واحد صاحب نے مشورہ دیا کہ میں ان کے دفتر سے سڑک (چندر یگر روڈ) کے پار سپاٹ لٹ پرنٹرز کے بلال شیخ صاحب کی چھ منزلہ نئی عمارت میں دفتر کا پتہ کروں۔ بلال شیخ صاحب نے ایک کمرہ کے لئے 1,40,000 روپیہ

سپاٹ لٹ چیمبرز ہمدرد پریس کے اسلم صاحب کو بیچ دیا۔ اسلم صاحب ہر کرایہ دار کو دفتر بیچ دینا چاہتے تھے۔ ہم نے اپنے چند بہی خواہوں سے اس معاہدہ کے تحت رقم ادھار پکڑی کہ ان کی یہ رقم ان کے اشتہاروں کی ایڈوانس ادائیگی سمجھی جائے گی۔ ہمارا یہ دفتر پاکستان کی ایک بڑی اور معتبر کاروباری سڑک آئی آئی چندری گر روڈ کی ایک گلی میں سڑک سے کوئی پچاس گز ہٹ کر واقع ہے۔ سامنے سے گلی بند ہے اس طرح ہم ٹریفک کے شور شرابہ، گرد و غبار اور دھوئیں سے بچے ہوئے ہیں۔ ہماری گلی اخباری اداروں کی منڈی ہے۔ بے شک اللہ بڑا ہی مہربان ہے۔

انجینئرنگ رویو کی ابتدا

جس روز مجھے انجینئرنگ رویو نکالنے کا اجازت نامہ ملا، وہ میرے لئے بے پایاں مسرت کا دن تھا۔ اس اجازت نامہ سے 90 دن کے اندر مجھے انجینئرنگ رویو کا پہلا شمارہ نکالنا تھا۔ اس دوران رضا خٹک صاحب کا بطور ایڈیٹر انتخاب ہو چکا تھا۔

یہ ذوالفقار علی بھٹو کی بادشاہی کے دن تھے کئی صنعتیں قومی تحویل میں لی جا چکی تھیں۔ صنعت کار سہما ہوا تھا۔ مل کا مزدور مل مالکان کے خلاف باغی ہوا تھا۔ ایسے ماحول میں نئی صنعتوں کے لگنے کا سوال ہی نہیں تھا۔ اس ماحول میں سیٹھ نے اپنا سرمایہ رہائشی فلیٹوں میں لگانا شروع کر دیا۔ یہ فلیٹ تمام شہریوں کو بیچ دیئے جاتے تھے۔ اس سے ایک طرف روٹی، کپڑا اور مکان کے نعرہ کی جزوی تکمیل ہوتی تھی تو دوسری طرف اس کاروبار کے قومی تحویل میں جانے کا خدشہ نہیں تھا کہ یہ غریب اور متوسط لوگوں کی ملکیت تھے۔ کراچی کی حد تک ہر طرف فلیٹوں کی تعمیر کا ایک وسیع سلسلہ جاری تھا۔

اس ماحول میں میرے ذہن میں انجینئرنگ سے مراد مکانات اور فلیٹوں وغیرہ کی تعمیرات کا شعبہ تھا۔ میرا خیال تھا کہ انجینئرنگ رویو تعمیراتی سرگرمیوں کا رسالہ ہوگا۔ لیکن شروع میں ہی اس کا رخ کسی اور طرف چلا گیا۔

سودا میں سودا ہوتے ہیں

اکتوبر 1975 میں ماہ نامہ انجینئرنگ رویو کا پہلا شمارہ شائع ہوا تھا اس کا اجرا کیوں ہوا۔ یہ جاننے کے لئے بات 1960 سے شروع کرنی ہوگی۔ جب میں طبی وجوہات کی بنا پر فوج سے فارغ ہو کر آ گیا تو سوال اٹھا کہ اب مجھے کیا کرنا ہے۔ دوبارہ طالب علم بننا مجھے قبول نہیں تھا۔ لیکن کم تعلیم (صرف میٹرک) کی بنیاد پر کلرکی ہی مل سکتی تھی۔ افسری کا مزہ چکھ لینے کے بعد کلرک بننا مجھے قبول نہیں تھا۔ ان حالات میں 'اپنا بزنس' ایک خوبصورت تصور تھا۔

اس کی ابتدائی تربیت کے لئے ابا جان مرحوم نے جامعہ مسجد روڈ راولپنڈی پر ایک جنرل سٹور پر ایک بزرگ دکاندار کے پاس بندوبست کر دیا۔

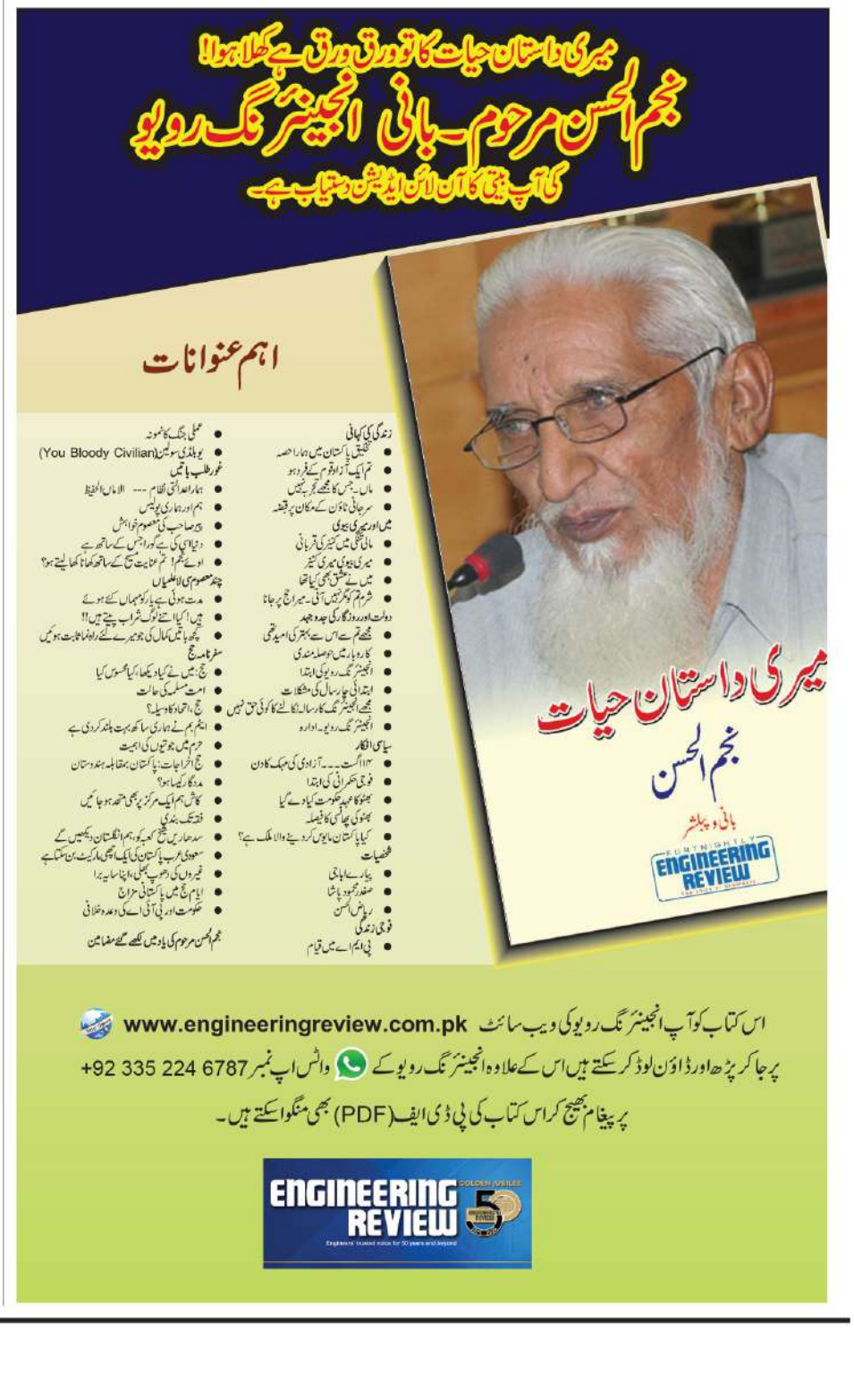
ایک روز سڑک پر ایک واقف کو جاتے دیکھا تو شرما، گھبرا کر دکان کے پچھلے حصہ میں جا چھپا۔ اس کیفیت سے باہر آنے میں میرے بزرگ 'باس' نے مدد کی۔ اب انہوں نے منڈی بھیجنا شروع کر دیا۔ ایک روز پوچھنے لگے سو والے آئے ہو۔ سوا اور دا میں وقفہ کی وضاحت کرتے ہوئے کہنے لگے۔ سودا کرنے میں سو والعنی سوداؤ ہوتے ہیں۔ یہیں سے نفع نقصان کی ابتدا ہوتی ہے۔

بزرگ دکاندار کے پاس مختصر تربیت کے بعد میں نے سٹیلائٹ ٹاؤن راولپنڈی کے آخری سرے پر ایک گاؤں سے ملحق اپنی پہلی دکان



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ENGINEERING REVIEW GOLDEN JUBILEE 50

Sindh Seeks Investment in Vast Mineral Wealth to Drive Industrialisation and Economic Growth

Sindh Chief Minister Syed Murad Ali Shah has reaffirmed his government's commitment to attracting domestic and international investment in the province's extensive mineral resources, describing the sector as a major opportunity to accelerate industrialization, strengthen energy security, create employment and generate sustainable economic growth.



Presiding over a high-level meeting at the CM House, the Chief Minister reviewed the province's coal and non-coal mineral potential, ongoing mining operations, infrastructure requirements and opportunities for future investment. Minister for Mines and Minerals Syed Sardar Shah briefed the meeting on the province's geological resources, existing projects, investment prospects and the government's plans for sustainable mineral development.

Murad Ali Shah said Sindh possessed considerable mineral wealth that could play a transformative role in the provincial and national economy if explored and utilized through scientific methods, modern technologies and responsible mining practices.

He emphasized that the government's objective was not limited to extracting raw minerals but also included establishing processing and manufacturing industries to increase the value of natural resources, generate skilled employment and expand export opportunities.

Thar coal: A major energy and industrial opportunity

Thar coal remains the most significant component of Sindh's mineral wealth. According to the briefing, the Thar coalfield contains estimated reserves of 175 billion tones, offering substantial potential for indigenous energy production and industrial development.

The presentation also highlighted an estimated energy equivalent of 50 billion tones of oil equivalent (TOE) and coal-related gas-equivalent resources of approximately 2,000 trillion cubic feet (TCF).

The Chief Minister reviewed the progress and operational capacity of two major coal mining and power generation projects established under the China-Pakistan Economic Corridor (CPEC) early harvest program.

The first is the Sindh Engro Coal Mining Company (SECMC), established under a public-private partnership arrangement. The company has an annual coal mining capacity of 11.2 million tones and supports power generation of 1,980 megawatts.

The Sindh government holds a 54.7 per cent stake in the company, while Engro and its associates own the remaining 45.3 per cent. The provincial government has invested Rs12.9 billion in equity.

The second major project is Sino-Sindh Resources Limited (SSRL), established with Chinese investment. It has an annual mining capacity of 7.8 million tones and power generation capacity of 1,320 megawatts. The project represents private investment exceeding $2.6 billion.

These projects are also contributing to reducing dependence on imported coal, helping save foreign exchange and strengthening the country's capacity to utilize indigenous energy resources.

Opportunities beyond coal

While Thar coal dominates the province's mineral development landscape, Sindh has considerable investment potential in several other minerals that could support construction, manufacturing, steel production and export-oriented industries.

According to the Mines and Minerals Department, important mineral deposits include granite, iron ore, marble, limestone, Celestine, China clay, silica sand and lake salt.

Contd on page 13

2nd GPSC Chain Summit 2027 Kick Off

Pakistan's Textile Export Competitiveness Hinges on Green Supply Chains and Digital Transformation

Pakistan's textile and apparel industry must accelerate its transition towards environmentally responsible supply chains, digital technologies and internationally compliant manufacturing practices to remain competitive in global export markets, industry and academic experts emphasized during a gathering held at the Asma M. Hashmi STEM Center, NED University of Engineering & Technology, Karachi.



The discussion took place on the occasion of the launch of the second Global Procurement & Supply Chain Summit (GPS 2027), scheduled for January 20, 2027, in Karachi. The summit will focus on sustainable procurement, green supply chains, industrial automation, artificial intelligence, digital transformation and export competitiveness.

The occasion was attended by representatives from the textile and apparel industry, IT and engineering sectors, procurement and supply chain professionals, and the media representatives.

In the discussion, Hafiz Kashif, Director of Artistic Milliners, highlighted the growing importance of green supply chains, carbon emission reduction and sustainable sourcing in maintaining access to international markets.

He emphasized that global buyers, particularly those serving European and other environmentally conscious markets, are increasingly scrutinizing the environmental performance of their suppliers. Carbon footprints, energy efficiency, responsible raw material sourcing, water conservation and supply chain transparency are becoming important considerations in international procurement decisions.

Dr. Majida Kazmi, Director, Asma M. Hashmi STEM Center, NED University, highlighted the importance of digital transformation, artificial intelligence and technology-driven education in preparing Pakistan's industries and future workforce for emerging challenges.

She emphasized the need to develop greater awareness and practical understanding of AI, automation and digital technologies, particularly their applications in industrial operations, procurement and supply chain management.

The participants discussed the importance of stronger collaboration between universities and industry to bridge the gap between academia and industries, particularly as manufacturers explore AI-enabled systems, intelligent automation and data-driven decision-making.

At the end, Syed Faisal Ali, CEO, Horizon Summit Management, thanked the participants for their presence and valuable contributions. He particularly acknowledged the positive role of media professionals in highlighting Pakistan's industrial capabilities, professional talent and emerging opportunities.

Against this backdrop, the upcoming Global Procurement & Supply Chain Summit 2027, being organized by Horizon Summit Management, will bring together industry leaders, procurement and supply chain professionals, technology experts, policymakers and academic institutions to examine challenges and emerging opportunities across Pakistan's textile and apparel value chain. PR

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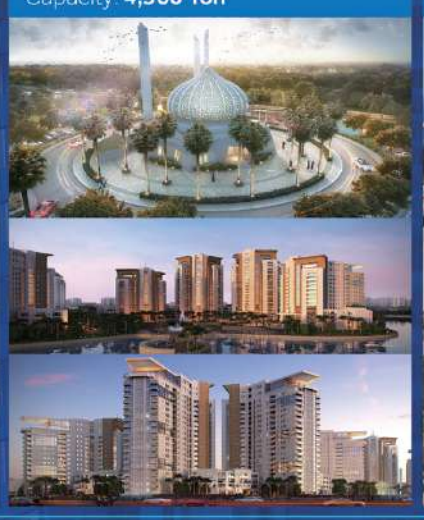
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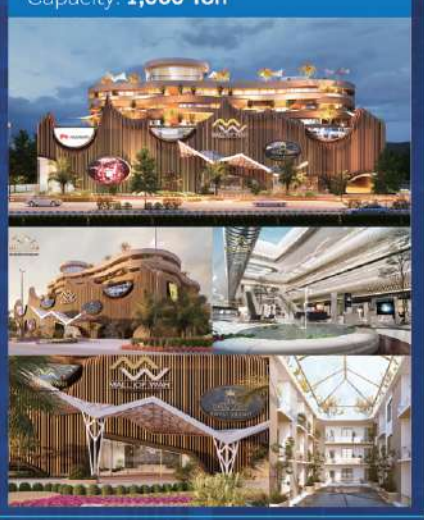
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Agriculture Review

Pakistan, Spain Agree to Strengthen Cooperation in Agriculture and Water Management

Pakistan and Spain have agreed to expand cooperation in agriculture, with a particular focus on olive cultivation, modern farming technologies and efficient water management.



The understanding was reached during a meeting between Federal Minister for National Food Security and Research Rana Tanveer Hussain and Spain's Minister of Agriculture, Fisheries and Food, Luis Planas Puchades, in Türkiye.

The two sides discussed opportunities for collaboration in olive farming, olive oil production and processing, agricultural research and the introduction of modern farming technologies. They also explored ways for Pakistan to benefit from Spain's experience in agricultural mechanization, precision farming and efficient irrigation systems.

During the meeting, the Spanish minister offered technical assistance in modern irrigation, precision agriculture and sustainable water management. He also expressed Spain's willingness to share its expertise and best practices with Pakistan.

Spain welcomed Pakistan's proposal to send a technical delegation to study its advanced agricultural practices, visit relevant institutions and explore opportunities for technology transfer.

Rana Tanveer Hussain highlighted Pakistan's potential to expand olive cultivation and develop its olive oil industry. He said Spain's experience in olive orchard management, modern processing techniques, quality standards and international marketing could help improve the productivity and competitiveness of Pakistan's olive sector.

The minister also emphasized the need to introduce water-efficient farming technologies to address growing water scarcity and climate-related challenges. He said modern irrigation systems and precision farming could help farmers increase crop yields, reduce production costs and make better use of available water resources.

The meeting also discussed closer links between agricultural research institutions, technical experts and relevant organizations in both countries to promote research, capacity building and the exchange of technology.

Both countries expressed their commitment to strengthening agricultural ties through technical cooperation, knowledge sharing and the adoption of sustainable farming practices. - ER

Construction of Roads Connecting Layyah–Taunsa Bridge

Federal Minister for Communications Abdul Aleem Khan has announced the formal commencement of construction work on roads connecting both sides of the Layyah–Taunsa Bridge over the River Indus, saying a long-standing commitment to the people of South Punjab is finally being fulfilled.

During an inspection of the ongoing construction work, the minister said the bridge over the River Indus had been completed nearly a decade ago, but the absence of connecting roads on either side had prevented local residents from benefiting fully from the facility.He said the National Highway Authority (NHA) had now initiated practical measures to complete the missing road links, with the entire construction project expected to be finished within two months.Abdul Aleem Khan said the completion of the connecting roads would establish direct communication between Layyah in Punjab and Taunsa in Dera Ghazi Khan district, significantly reducing travel time between the two areas. A journey that currently takes several hours would be reduced to just a few minutes, providing considerable relief to residents, commuters and transporters.The minister also announced that appropriate lighting arrangements would be installed on the bridge to ensure safer travel, particularly at night. He added that Prime Minister Shehbaz Sharif would inaugurate the newly constructed roads after completion.Equal development rights for South PunjabEmphasising the importance of balanced regional development, Abdul Aleem Khan said the people of South Punjab had

Contd on page 15





Sindh Seeks Investment in Vast Mineral Wealth to Drive Industrialisation and Economic Growth

Contd from page 10

Granite deposits in Nagarparkar, district Tharparkar, offer opportunities for the development of dimension stone industries, decorative products and modern cutting and polishing facilities. Establishing processing units near mining locations could help increase the commercial value of these deposits.

Iron ore deposits in Thatta, Jamshoro and Tharparkar present opportunities for further exploration, mineral beneficiation and the development of steel-related industries.

Similarly, marble deposits in Thatta and Jamshoro could support the production of finished stone products, while limestone reserves across Khairpur, Dadu, Jamshoro, Sukkur, Hyderabad, Thatta and Karachi could provide raw material for cement manufacturing and construction industries.

Other identified opportunities include celestite in Jamshoro, China clay in Tharparkar, silica sand in Jamshoro and Thatta, and lake salt deposits in Dadu, Sanghar and Tharparkar.

These resources offer potential for investment in processing, refining, manufacturing and the production of value-added goods.

The Chief Minister directed the relevant authorities to facilitate investors interested in developing these sectors, stressing that local processing and manufacturing would generate greater economic benefits than exporting unprocessed minerals.

Responsible mining and community development

The meeting also examined the social and environmental responsibilities associated with mineral development, particularly in areas where mining activities directly affect local communities.

The Mines and Minerals Department highlighted the social development initiatives undertaken alongside the Thar coal projects, including employment generation, healthcare, education, clean drinking water and community infrastructure.

Under Thar Coal Block-I, approximately 5,000 jobs have been generated, with nearly 97 per cent of the workforce belonging to Sindh. The briefing also reported more than 20,000 direct local employment opportunities cumulatively during project development and implementation.

Community initiatives include a 250-bed hospital in Islamkot, healthcare facilities, reverse osmosis (RO) plants and technical training programs designed to equip local youth with skills required by the mining and energy industries.

Under Block-II, approximately 2,350 local people are employed through SECMC-related operations. Around 94 per cent of the workforce comes from Sindh, including 60 per cent from Thar.

The project also supports seven medical facilities providing free healthcare services and operates 33 reverse osmosis plants to supply clean drinking water to surrounding communities.

Environmental initiatives were another important component of the briefing. These include the plantation of more than 1.3 million trees under the Thar Million Tree Program, water treatment and reuse, biodiversity conservation, bio-saline agriculture and progressive land rehabilitation.

Murad Ali Shah stressed that mineral development must not come at the expense of environmental protection or community interests. He called for strict compliance with environmental standards, occupational health and safety regulations and appropriate arrangements for communities affected by mining activities, including resettlement where necessary.

Infrastructure and new investment avenues

The meeting also reviewed infrastructure requirements for expanding mining operations, particularly road connectivity, water supply and transportation facilities.

The proposed Thar Rail Connectivity Project, a joint venture between the federal and Sindh governments, was discussed as an important initiative to improve the transportation of coal from Thar to industrial centres across the country.

The railway link is expected to provide more efficient access to national markets and facilitate the wider utilization of indigenous coal by power plants and other industries.

The briefing also identified opportunities for alternative utilization of Thar coal, including coal briquetting and coal-to-urea production. These initiatives could open new avenues for industrial investment while supporting agricultural inputs, food security and foreign exchange savings.

To facilitate prospective investors, geological and exploration data are available, while 12 blocks have been developed following detailed drilling activities.

Government promises investor-friendly environment

Concluding the meeting, the Chief Minister reiterated that Sindh was open to domestic and international investment in its mineral sector. He encouraged strategic partnerships, joint ventures, technology transfer and the adoption of modern mining practices.

He directed the relevant departments to ensure transparent regulations, competitive investment opportunities, efficient administrative procedures and strong institutional support for investors.

The government, he said, wanted to transform Sindh's mineral resources into a foundation for long-term economic development, industrial expansion, employment generation and improved living standards.

He maintained that the success of the province's mineral development strategy would ultimately depend on balancing investment and commercial activity with environmental sustainability and the protection of communities living in resource-rich areas. - ER

Padel Super League 2026

on 18, 19 and 20 December 2026

Karachi is set to witness an exciting blend of sports and business networking as Padel Super League – Season 1 takes place on 18, 19 and 20 December 2026 at Legends Arena, DHA Phase 5, Karachi.

Organized by StarlinkXpo and co-organized by Sybrid Marketing & PR Solutions, this three-day sporting initiative aims to bring together leading companies, business professionals, corporate executives and industry representatives, with a particular focus on Pakistan's Electrical, Electronics, Power, Energy, Solar and related industrial sectors.

Going beyond a traditional sporting tournament, Padel Super League is envisioned as a platform where sports create opportunities for meaningful B2B networking, professional interaction and long-lasting business relationships. It will provide participating organizations with an opportunity to connect with industry leaders, explore potential collaborations, strengthen corporate relationships and represent their brands in a healthy and engaging environment.

The event will feature competitive Padel matches, corporate team participation, brand engagement activities and digital media exposure. Through planned live-stream coverage, social media campaigns, promotional content and outreach to leading digital media platforms, the initiative aims to extend its reach beyond the venue and bring greater visibility to participating organizations.

The organizers' aim is to introduce a distinctive corporate sporting platform that combines business networking, brand visibility and professional engagement under one roof.

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Strategic Entrepreneurial Frameworks for Engineering Innovation

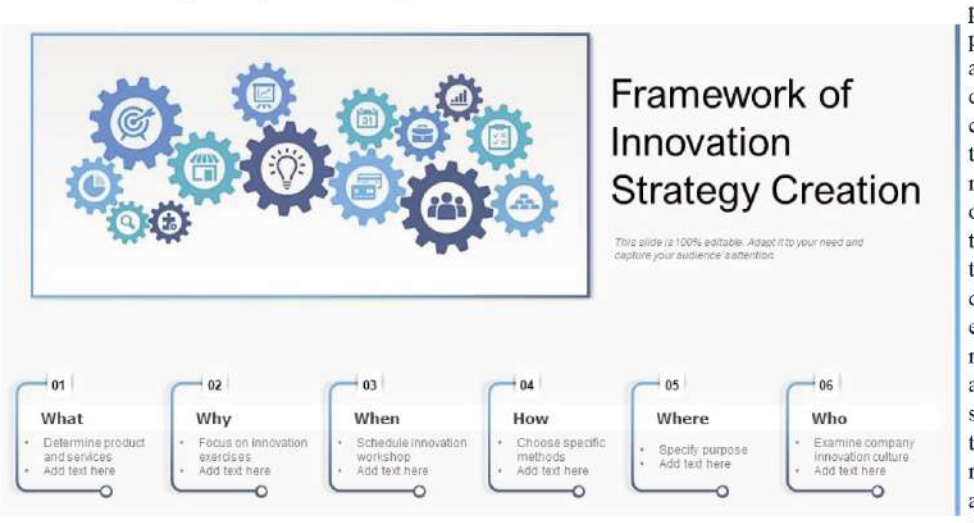
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The successful realization of engineering innovation requires a blend of technical skills and strategic entrepreneurial thinking: the ability to turn scientific discoveries and engineering solutions into commercially viable opportunities.

Strategic entrepreneurial frameworks provide an organized and structured way of identifying gaps in technology, understanding market needs, distributing resources, and creating new products or services. Engineers should not only think about technical performance but also about the key value-adding aspects of innovation from economic, social, and environmental perspectives. In this way, engineers will develop an entrepreneurial attitude and the ability to take risks, think strategically, and be creative in their approach to technology development. Such a fusion of engineering knowledge with business intelligence allows organizations to create innovations that are sustainable and solve complex industrial and societal problems.

An essential aspect of engineering innovation is opportunity-driven entrepreneurship, where opportunities for new technologies are identified in response to a need and then turned into viable products. Opportunities can be identified by engineers through industrial research, customer feedback, new technologies, and the analysis of operational issues. However, an opportunity cannot be identified simply by developing sophisticated technologies; it is necessary to determine whether a proposed solution can solve a real problem. Technical feasibility and market relevance can be considered together to enable engineering entrepreneurs to focus on more innovative projects. This is also a framework that allows engineering companies to constantly monitor new markets, anticipate technological disruptions, and create competitive advantages before other companies, particularly competitors, enter the market.



Another important framework is design thinking and human-centred innovation, which focuses the engineering process on users and stakeholders. This also challenges engineers to explore user experiences, understand practical challenges, come up with innovative ideas, and try out various solutions repeatedly. Human-centred innovation takes into account usability, accessibility, affordability, and customer satisfaction, whereas conventional engineering solutions might focus only on technical aspects. Incorporating entrepreneurial thinking into these activities can help engineering teams develop user needs into commercially viable products and services. Moreover, iterative prototyping and experimentation help to minimise uncertainty in the design process, identify design problems early in development, and increase confidence in the product's performance, while making it more likely that technological innovations align with consumer expectations.

Another strategic approach, the lean startup, is useful because it focuses on experimentation, rapid prototyping, and learning. Engineering entrepreneurs face a high level of uncertainty in the areas of customer expectations, production costs, technology performance, and market acceptance. The lean approach encourages the development of minimum viable products, which can be used to test products under realistic conditions, rather than developing extensive products that are ready for production. Organisations can enhance their engineering designs and business models by gathering feedback from potential customers and industrial users. This process adopts a build-measure-learn approach, enabling innovators to make evidence-based decisions, eliminate ineffective concepts, and rapidly improve solutions. Lean entrepreneurship, therefore, minimises development risks and speeds up the commercialisation of engineering innovations.

In addition to strategic resource management, collaborative innovation is also a fundamental part of entrepreneurial engineering frameworks. Creating new technologies typically demands a high level of funding, expertise, infrastructure, intellectual property protection, and interdisciplinary collaboration. Engineering organisations must, therefore, develop effective resource allocation strategies that balance research activities with commercial objectives. Partnerships among universities, industries, technology companies, research institutes, and investors can help speed up the transfer of knowledge and provide access to complementary skills. Open innovation also allows companies to leverage external expertise and bring it in to complement their own internal research and development efforts, thereby spurring innovation and discovery. By working strategically with partners, engineering entrepreneurs can overcome resource constraints, enhance development efficiency, and add more technologies to their toolbox that will help them remain competitive in the long term.

Another emerging dimension of strategic entrepreneurial frameworks is technology commerc ialisation and business model innovation. While a successful invention must be technically sound, technical excellence alone is not enough to make it a successful innovation; it also requires a proper value proposition, revenue structure, distribution plan, and market entry strategy. Engineering entrepreneurs should analyse the feasibility and potential manufacturing scale of production, the buying habits of their customers, the competitive environment, and potential opportunities for intellectual property. There are several new business models, such as product-as-a-

Contd on page 15

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Construction of Roads Connecting Layyah–Taunsa Bridge

Contd from page 1

the same right to development, prosperity and basic facilities as residents of other parts of the country.He said addressing the longstanding deprivations of the region and ensuring the delivery of legitimate public rights remained among the government's priorities.The minister also referred to the political and administrative demands of South Punjab, saying its people deserved their constitutional, political and administrative rights, including the establishment of a separate province.He maintained that addressing these demands was important for sustainable development and finding lasting solutions to the challenges facing the region.The proposed South Punjab province has remained a significant political and administrative issue, with supporters arguing that a separate provincial structure could improve governance, public service delivery and access to development resources in the region.Compensation for acquired landThe Federal Minister also reviewed arrangements for compensating landowners whose properties have been acquired for the construction of the connecting roads.He said the NHA had transferred the entire amount required for land acquisition compensation to the district administration.Directing the Commissioner and Deputy Commissioner to ensure prompt disbursement, Abdul Aleem Khan stressed that affected landowners must receive full compensation for every marla of land acquired for the project.■

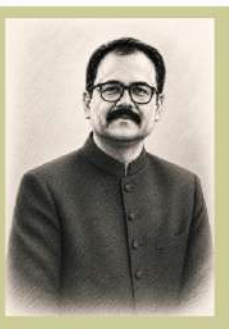
Strategic Entrepreneurial Frameworks for Engineering Innovation

Contd from page 14

service, licensing schemes, digital platforms, and technology partnerships, that can allow the creation of alternative value-creation opportunities for engineering discoveries. Incorporating commercialisation plans into the early R&D phase helps organisations close the gap between laboratory results and real-life industrial applications.

Other pillars of sustainable engineering entrepreneurship are risk management, strategic foresight, and organisational adaptability. The digital revolution, new regulations, climate change, shifting consumer demands, and volatile economic conditions are all impacting technological markets. Technical, financial, operational, cybersecurity, and market-related risks, therefore, need to be assessed throughout the innovation process by engineering innovators. Organisations can prepare for uncertainty and guide their strategies through scenario planning, feasibility studies, predictive analytics, and portfolio diversification. At the organisational level, it is all about setting the stage for experimentation, knowledge-sharing, and tolerance for carefully managed failure, all of which create an environment in which employees feel free to explore ideas outside the box. This flexibility is key to helping engineering firms respond effectively to disruption whilst keeping their long-term innovation goals in mind.

Strategic entrepreneurial models for engineering innovation demand a holistic strategy that involves technological excellence, business savvy, sustainability, and strategic leadership. Innovation in future-oriented engineering companies needs to be understood and measured not only in terms of profit and productivity but also in terms of environmental responsibility, social impact, resource efficiency, and long-term industrial resilience. New technologies, such as artificial intelligence, robotics, smart materials, renewable energy solutions, and intelligent manufacturing, offer many potential entrepreneurial areas for value creation. However, to make use of these opportunities, a coordinated framework is needed to align research, experimentation, investment, commercialisation, and continuous improvement. Educating engineers in entrepreneurial principles through their education, research, and industrial activities can produce a new breed of engineering innovators who can convert complex problems into valuable technological solutions and contribute to sustainable economic development.■



سید نوید حیدر جعفری

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کراچی: پانی سے ہائیڈروجن گیس کشید کرنیوالا جنریٹر تیار

پانی کو الیکٹرولیس کے عمل سے گزار کر ہائیڈروجن اور آکسیجن میں تقسیم کیا جاتا ہے، حاصل ہونیوالی ہائیڈروجن کو فوری جلانے کیلیے استعمال کیا جاسکتا، نوجوان انجینئرز

پاکستان کو درپیش توانائی کے بحران، مہنگے درآمدی ایندھن اور صنعتی پیداواری لاگت میں اضافے کے درمیان کراچی کے نوجوان انجینئرز نے اسٹارٹ اپ پاک ہائیڈرو (PAKHYDRO) کی شکل میں ایک ایسا مقامی حل پیش کیا ہے جو مستقبل میں ملک کے توانائی کے منظرنامے میں اہم کردار ادا کر سکتا ہے۔ اسٹارٹ اپ کی ٹیم نے پانی سے ہائیڈروجن گیس کشید کر نیوالا الیکٹرولیس جنریٹر تیار کیا ہے، جس کے ذریعے پیدا ہونیوالی ہائیڈروجن کو شعلے اور حرارت کی شکل میں صنعتی، تجارتی اور گھریلو مقاصد کیلیے استعمال کیا جاسکتا ہے۔





اس پروٹوٹائپ کی بنیادی خصوصیت یہ ہے کہ پانی کو الیکٹرولیس کے عمل سے گزار کر ہائیڈروجن اور آکسیجن میں تقسیم کیا جاتا ہے۔ حاصل ہونیوالی ہائیڈروجن کو فوری طور پر جلانے کیلیے استعمال کیا جاسکتا ہے، جبکہ اس نظام کو روایتی گیس اور دیگر فوسل فیول پر انحصار کم کرنے کے متبادل کے طور پر پیش کیا جارہا ہے۔ منصوبے کی قیادت محمد آیان کررہے ہیں جو سرسید یونیورسٹی آف انجینئرنگ اینڈ ٹیکنالوجی کے الیکٹریکل انجینئرنگ کے طالب علم اور پاک ہائیڈرو کے بانی و چیف ایگزیکٹو آفیسر ہیں۔

ٹیم میں ڈاکٹر عثمان علاؤالدین شریک بانی اور چیف ٹیکنالوجی آفیسر ہیں، جو این ای ڈی یونیورسٹی کے شعبہ میکینکل انجینئرنگ میں پروفیسر ہیں، جبکہ امیر علی شریک بانی اور چیف آپریٹنگ آفیسر ہیں، جو سرسید یونیورسٹی کے شعبہ الیکٹریکل انجینئرنگ میں اسسٹنٹ پروفیسر کے فرائض انجام دے رہے ہیں۔ ڈاکٹر عثمان علاؤالدین کے مطابق موجودہ پروٹوٹائپ میں تقریباً 6 سے 8 منٹ کے اندر ایک کلوگرام ہائیڈروجن گیس تیار کرنے کی صلاحیت کا دعویٰ کیا گیا ہے۔ اس عمل میں تقریباً 8 سے 10 لیٹر پانی استعمال ہوتا ہے، جبکہ بجلی کی کھپت اور پیداواری لاگت کا انحصار جز میٹر کی استعداد اور مسلسل آپریشن پر ہوگا۔ ان کا کہنا ہے کہ اگر بجلی کی ضرورت شمسی توانائی سے پوری کی جائے تو اس نظام کو قابل تجدید توانائی کے ذریعے چلایا جاسکتا ہے۔ ان کا کہنا ہے کہ اس ٹیکنالوجی کو تجارتی بنیادوں پر متعارف کرایا جائے تو پاکستان میں ہائیڈروجن ٹارچ سسٹمز کی مقامی مینو فیکچرنگ، تنصیب، مرمت اور سروسز کا نیا شعبہ وجود میں آسکتا ہے۔ ان کے ابتدائی تخمینے کے مطابق اس صنعت کا حجم 40 سے 50 ارب روپے تک پہنچے اور اس سے 8 سے 10 ہزار روزگار کے مواقع پیدا ہونے کی صلاحیت رکھتا ہے۔

منصوبے کے بانی محمد آیان کے مطابق اس پروٹوٹائپ تک پہنچنے کیلیے ٹیم نے مختلف ڈیزائنز اور تجربات کیے۔ ابتدائی مراحل میں مختلف سیل ٹیکنالوجیز پر کام کیا گیا اور مسلسل تحقیق و ترقی کے بعد ایسا مقامی نظام تیار کیا گیا، جو ضرورت کے مطابق ہائیڈروجن پیدا کرسکتا ہے۔■

KMC کی 188 ترقیاتی اسکیموں میں مبینہ بے ضابطگیاں

7.5 ارب روپے کے استعمال کی تحقیقات کا مطالبہ

ممبر صوبائی اسمبلی و ممبر پبلک اکاؤنٹس کمیٹی سندھ طٰہٰ احمد خان نے چیئرمین پبلک اکاؤنٹس کمیٹی شارکھوڑو کو خط لکھ کر کراچی میٹروپولیٹن کارپوریشن (کے ایم سی) کی ترقیاتی اسکیموں اور ٹینڈرنگ کے عمل میں مبینہ بے ضابطگیوں کی تحقیقات کرانے کا مطالبہ کیا ہے۔



خط میں انہوں نے مطالبہ کیا کہ کے ایم سی کی 188 ترقیاتی اسکیموں پر خرچ ہونے والے 7.5 ارب روپے کے استعمال کی مکمل تحقیقات کرائی جائیں، جبکہ رواں مالی سال کے دوران 15 سے 16 ارب روپے مالیت کے ترقیاتی ٹینڈرز کے عمل میں بھی شفافیت یقینی بنائی جائے۔

طٰہٰ احمد خان نے کہا کہ کے ایم سی کی ترقیاتی اسکیموں اور ٹینڈرنگ کے پورے عمل کی چیف منسٹر انسپکشن ٹیم (سی ایم آئی ٹی) کے ذریعے انکوائری کرائی جائے تاکہ ترقیاتی ٹھیکوں میں مبینہ بے ضابطگیوں اور غیر ضروری

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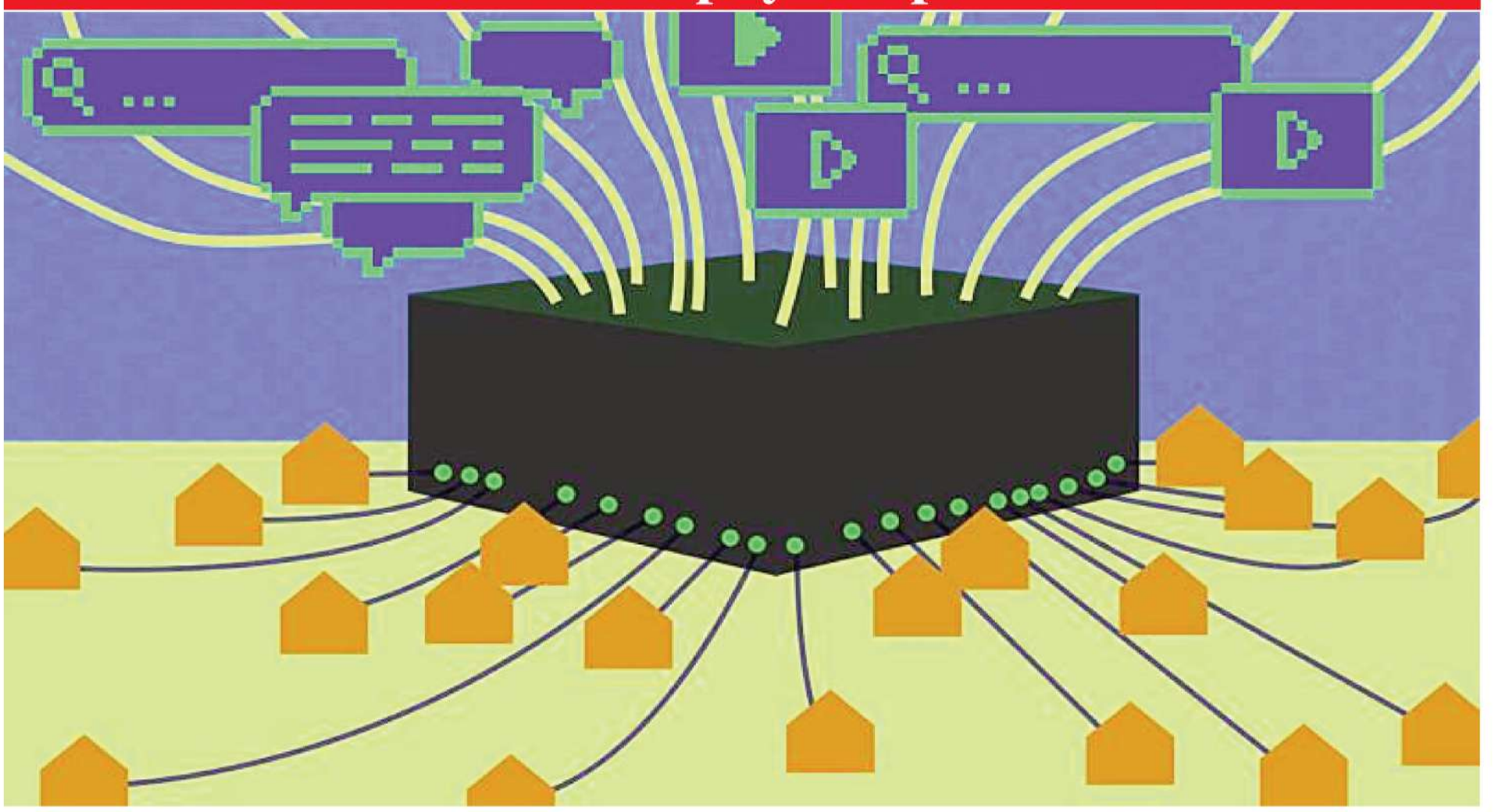
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Source: Rescue 1122 Punjab, 2025 data, as reported by The GEO News.



Data centers need power—lower-income rural residents pay the price



As the engines of artificial intelligence, large data centers can consume as much power as medium-sized cities, straining grids and prompting expensive upgrades to U.S. energy infrastructure.

New research finds that residents, and especially lower-income and rural residents, are disproportionately bearing the costs.

In the study, published Nov. 9 in Nature Energy, Cornell researchers analyzed growth in energy demand and infrastructure projects for four major U.S. power grids from 2020 to 2025 and found that data centers have hiked wholesale energy prices and on average paid only 38% of the infrastructure costs linked to their growth—$3.12 billion of an $8.25 billion bill in 2025. The remaining $5.13 billion, or 62%, fell largely on residents, with the lowest-income households seeing extra energy costs up to 28% of their incomes.

"We were trying to answer a very simple question: With the booming of data centers, who pays for that expansion and who benefits?" said Fengqi You, the Roxanne E. and Michael J. Zak Professor in Energy Systems Engineering in the Cornell Duffield College of Engineering. "It's not just a question of generating enough electricity but of whether the rules for paying for the grid are keeping pace with who is driving new demand."

The research is the first multiregion, long-term assessment of how data center development impacts infrastructure growth and how costs are distributed across communities. It comes amid a boom in data center construction.

The researchers found that transmission investment in energy infrastructure projects increased from $2 billion in 2020 to $34 billion in 2025, with data centers driving much of that rise. Debates are ongoing—from local communities to state governments to Congress—about who picks up the bill as growth accelerates; data centers are projected to consume between 8% and 17% of U.S. electricity by 2030, with 70% to 80% of that attributed to AI.

With first author and postdoctoral researcher Cheng Feng, You also looked at data centers' economic benefits, finding that each gigawatt of data center capacity can create 15,000 jobs across the economy, with an average of 2,700 jobs directly associated with the data center (although not necessarily all onsite).

"In a lot of discussions right now, people take one side or the other, completely yes on data centers or completely no," said You, director of the Cornell AI for Sustainability Initiative. "But there are benefits and costs, and the key issue in the end is how to balance the trade-offs."

Sharing the cost of power infrastructure

The team analyzed data from 4,000 existing and proposed data centers, as well as power-price records, rate filings from utilities, power-line plans and federal household and job data. The major grids they studied encompass regions with the largest clusters of data centers, including the southern San Francisco Bay Area; North Texas around Dallas-Fort Worth; the Midwest; and the mid-Atlantic region, including northern Virginia, where the biggest concentration of data centers has been built to date.

State incentives for data centers have provided returns on the investments, if inconsistently, the researchers found. Some states, such as California, reaped $180 in worker income for every dollar spent, while Virginia increased income $2 for every dollar invested. The researchers determined that the presence of an existing, qualified workforce was a stronger indicator of high returns than the amount of incentive spending.

Data centers also increased wholesale electricity prices, the amounts utilities pay regional power markets before delivering the electricity to homes. In the most affected hubs, data center growth raised those prices by nearly 10% or more by 2025. In Virginia, the costs jumped 15% and in California's southern Bay Area, 20%. In contrast, residents in New York and New England, where data center construction has been limited, have not seen clear price increases due to data center expansion, the researchers found.

"I think that means we're at a good starting point in New York to think about the next steps," You said. "Economic benefits, job benefits, investment, fairly allocating the costs—these are the dimensions and trade-offs we need to consider."

A key problem is how the costs of new infrastructure projects are currently shared: The allocation is often based on previous patterns of energy consumption.

"It's kind of a chicken-and-egg problem," You said. "Because if you're going to build a data center, you need to expand this power infrastructure. Otherwise, there's no electricity for them to run. But before they build, they're not using energy. So with this model of relying on past consumption, households end up taking on much of the infrastructure costs."

Many more rural and lower-income residents saw proportionally higher bills; the share of rural families shouldering a high energy burden—spending more than 6% of their incomes on energy—rose 76% more than among urban residents. The authors cite a national survey finding that rural residents are also less likely to use AI tools like ChatGPT than urban residents.

The impact on energy bills also has a wide geographical reach. For example, residents in New Jersey, Pennsylvania and Ohio help pay for grid upgrades linked to data center growth in Virginia, the researchers said.

"You do not have to live next to a data center to help pay for its power infrastructure," You said. "The grid connects communities across states, and cost-sharing rules connect them financially."

Using insights from the data, You and Feng recommend changes to cost-sharing rules and strategies to lower burdens. In all four regions, they found that, if data centers cut back power use during 22 of each region's peak demand hours each year, they would relieve strain on the grid and minimize the need to expand. Tech companies, which often own multiple data centers in different states and even countries, could shift operations to another region during the peak demand.

"It's feasible, and the challenge is more about implementation," You said. "Coordination is needed, but there's a clear benefit for better coordination."

States could also charge data centers directly in line with the new demand they add, or institute programs, like a recent law in Minnesota, to direct funds to low-income households to offset higher energy expenses. Tax incentives could also be tied to job creation and increased wages, so those benefits are better ensured.

You and Feng's recommendations come as states grapple with how to share costs; six states have recently set special terms for very large energy consumers, and in March, seven major technology companies signed the White House Ratepayer Protection Pledge, a commitment to pay for required grid updates.

"This is an issue that connects directly to debates in many states and in Congress," You said. "We want to provide science-based evidence and concrete data so that all the stakeholders can better understand the picture and weigh their options." - TX

Inspired by elephant trunks, shape-shifting robots bend, grab and team up

Researchers at Colorado State University have developed a flexible robot that functions like an elephant's trunk to grip objects, with a goal of one day sending teams of these machines to aid in space exploration or to help with any number of other complex tasks.

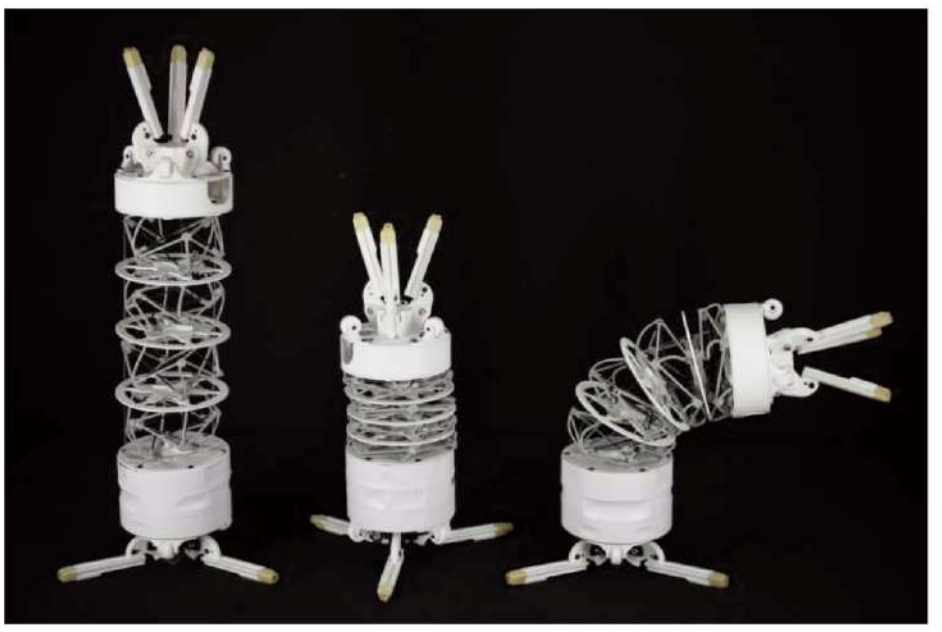
The robots are described in Nature Machine Intelligence and are designed to address limitations in current robotic systems, which are more commonly built from rigid blocks that limit the shapes they can form.

These new robots were made instead with a design approach called tensegrity, in which stiff rods are held in place by a web of tensioned cables rather than being rigidly locked together. This makes them flexible and lets them bend, collapse and change shape as needed. Like tentacles, they have no traditional joints yet feature a pair of gripping claws at both ends of their tubelike bodies that can attach to partner robots for teaming or to manipulate items.

Claws connect robots into adaptable teams

The robots were developed by Associate Professor Jianguo Zhao and his team in the Department of Mechanical Engineering at CSU. He described the robots as generalists that could one day help with search-and-rescue efforts or support humans in a manufacturing setting, among other examples.

"Often the physical structure of robots is fixed, but our approach allows these flexible systems to adapt their shape to their environment and to the potentially changing needs of their mission by collapsing, stretching or grasping," he said. "They are also modular, meaning each robot works like a building block: It can operate on its own or connect with others to form bigger, more capable shapes."



He added that the dual claw-attachment design avoided the need for magnets, which can sometimes fail as connection points. Zhao said the combination of claw attachments and body structure opens many possibilities for their eventual use.

"They can bend around to lift and carry different-sized objects with their body or to navigate difficult terrain like a snake would," Zhao said. "The claw attachment also reduces the chance of misalignments during connections—making it easier for them to team up and form loops, chains and branches of different sizes to accomplish their tasks. They are very adaptable to the situation and goals."

Testing motors and movement

Mahmud Hasan Saikot is a doctoral student at CSU and co-first author on the paper. He took over the robot initially designed by team member Sydney Spiegel, the paper's other co-first author. Saikot said the team went through several design ideas before landing on this version of the robotic arms.

One of the challenges was finding motors that were small enough to support the various types of movements but were also powerful and reliable over longer periods of time. He said the team spent a lot of time testing configurations and taking the robots into the field to see how they handled crossing natural landscapes in addition to work in the lab.

Toward autonomous robot teams

The next step in the project, he said, will be developing the ability for these systems to work with humans and on their own. The team also hopes to make them operate at faster speeds.

"Right now, these systems need to be piloted by a human. However, we have already demonstrated that two robots can find each other and connect on their own. In the future, we can envision mostly autonomous teams of tens or even hundreds of them—attached through the claws—traveling to a location and then deploying for a specific purpose," he said. "With that in mind, we want to continue improving their ability to work together with minimal human supervision."

Other CSU-affiliated researchers listed as authors on the paper include Sudheera Akalanka Kariyawasam, Andrew Stefka and Josh Chrisler. - TX

Shape-shifting rubber blades could make tidal power cheaper

Fitting tidal turbines with flexible rubber blades could enable the machines to generate cheaper power by making them simpler and tougher, a study published in the journal Nature suggests.

Rubber blades that change shape in strong currents can generate as much electricity as today's most advanced designs, without the complex machinery they need to survive at sea, researchers say.

Their findings show the blades naturally bend to shed excess force, reducing by up to one-third the rapid swings in load that wear turbines out.

The approach could ultimately eliminate the costliest and most failure-prone parts of tidal turbines, the team says, helping unlock a clean energy source that—unlike wind and solar—can be predicted years in advance.

The U.K. aims to install 1 gigawatt of tidal stream capacity by 2035, enough to power around 1 million homes. International projections estimate that more than 300 gigawatts could be generated by tidal power worldwide by 2050.

However, fast-flowing tidal channels are among the harshest places on Earth to build a machine. Turbulence, waves and shifting currents batter turbine blades with constantly fluctuating forces, causing fatigue, shortening lifespans and leading to costly unplanned downtime.

Blades that bend

To cope, the largest tidal turbines rely on a system of motors, sensors and bearings—known as pitch control—that twists blades away from the flow when currents become too strong. These systems are expensive, difficult to maintain underwater and a major source of breakdowns.

Now, engineers from the University of Edinburgh and Michelin have designed and tested at experimental scale a blade that does the job by itself.



Taking inspiration from nature—where fish and trees bend to cope with strong water and wind flows—the team developed blades made of flexible rubber with a stiff internal steel spar running from root to tip.

As the current strengthens, the trailing edge bends and flattens the blade's curved profile, automatically shedding excess load without the need for hinges, bearings or actuators.

The team tested a 1.26-meter (4.1-foot) model turbine at the University of Edinburgh's FloWave Ocean Energy Research Facility, a 25-meter (82-foot) circular tank that recreates the turbulence found at real tidal energy sites. Cameras submerged in the tank filmed the blades changing shape as they spun.

Matching output while reducing strain

Combining their measurements with simulations of a full tidal cycle, researchers found that the rubber-bladed turbine produced the same amount of energy as a conventional turbine with active pitch control under the same conditions.

At the same time, the flexible blades reduced the rapid load fluctuations that drive fatigue damage—which pitch control systems struggle to respond to—by up to 29%. Because rubber has a similar density to water, the blades can be made neutrally buoyant, further limiting load fluctuations, the team says.

The new design could, if successfully validated at a larger scale, enable the construction of lighter blades and support structures, more powerful generators and cheaper maintenance, all of which would reduce the cost of tidal electricity. It could also open up highly energetic, turbulent sites currently deemed too punishing for tidal turbines, the team says.

Commercial-scale promise still needs testing

Computer simulations of a 20-meter (66-foot) turbine suggest that the blades could be similarly effective at commercial scale. Early calculations suggest full-size rubber blades could potentially exceed the 20-year service life expected of current turbines, the team says.

The work remains at the research stage, and further development and testing would be required before any potential industrial application or commercialization, the team says.

Michelin has filed a patent on the technology, and the university, a leader in the field of tidal energy, holds related patents.

Professor Ignazio Maria Viola, of the University of Edinburgh's School of Engineering, who co-led the study, said, "Tidal energy is one of the most predictable renewable resources we have, but the sea is so unforgiving that turbines have needed complex machinery just to survive it.

"Our blades do that job on their own. By simply bending, they shed excess load and smooth out damaging fluctuations, while producing just as much energy. Removing parts that are expensive and prone to failure could help make tidal power a cost-competitive pillar of a secure, net-zero energy system."

Dr. Zhehong Zhang, of the University of Edinburgh's School of Engineering, co-first author of the study, said, "The idea is simple: let the blades adapt to the flow, rather than relying on complex mechanical systems to withstand harsh ocean currents. Our research shows that flexible blades can reduce damaging loads without compromising energy capture, making it possible to harness powerful, turbulent tidal currents that are currently too challenging to exploit."

Bertrand Daval, vice president of research and development for composite solutions at Michelin, who co-led the study, said, "Michelin's expertise lies in understanding how rubber performs under heavy, repeated loads in demanding environments. This research is a great example of how this knowledge and experience can be applied to help tackle one of the toughest challenges in renewable energy: developing turbines capable of withstanding demand-