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Who Will Pay the Environmental Cost of Chiniot's Iron and Copper Boom?

Pakistan has long dreamt of transforming its mineral wealth into economic prosperity. Few projects embody that dream more than the Chiniot Iron Ore and Copper Project in Punjab. Successive governments have described it as a game-changing opportunity that could reduce Pakistan's dependence on imported steel, create thousands of jobs, attract foreign investment, and become the country's first indigenous integrated iron and steel complex.

The numbers are certainly impressive. Official estimates suggest that Chiniot's mineral deposits contain around 250 to 267 million tonnes of iron ore along with associated

copper mineralization. The proposed project envisions an integrated mining, processing and steel-making complex requiring an



investment of approximately \$1.3 billion. It aims to produce one million tonnes of steel annually while operating over a projected life

exceeding four decades. For a country that imports billions of dollars worth of steel products annually, the eco-

nomic rationale is obvious. Yet there is another question that receives far less attention whenever politicians speak about mineral wealth and industrial transformation.

Who will pay the environmental cost of Chiniot's mineral boom?

The Promise

Punjab Mineral Company describes the project as Pakistan's first indigenous iron ore mining, processing and steel mill complex. The project includes underground mining operations, iron ore processing facilities and steel manufacturing units. Government documents indicate that international consulting firms from Germany and elsewhere have been involved in resource estimation and feasibility studies.

Underground mining has been proposed primarily to minimize environmental and social impacts on the surface. A 100-metre crown pillar has been proposed to preserve the integrity of surface structures while

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Who Will Pay the Environmental Cost of Chiniot's Iron and Copper Boom?

Contd from page 1

access to the ore body is expected through shafts and inclined tunnels.

From an engineering perspective, the proposal represents a significant technological undertaking for Pakistan's mining sector.

If successfully implemented, the project could substantially reduce steel imports, generate employment opportunities and stimulate downstream industries.

But engineering success and environmental sustainability do not always move together.

Mining Changes More Than Mountains

Mining projects do not merely remove minerals from beneath the ground. They fundamentally alter landscapes, water systems and ecosystems.

The first environmental question surrounding Chiniot concerns water.

Iron ore mining and mineral processing require considerable quantities of water. Processing plants consume water for crushing, washing, separation and beneficiation processes. Steel manufacturing itself is also highly water-intensive.

Punjab is already facing severe groundwater depletion across several districts. Agriculture continues to compete for increasingly scarce water resources while climate change is altering rainfall patterns throughout the province.

Before celebrating Chiniot's economic potential, policymakers must answer an uncomfortable question: where will the project's water come from, and what will happen to local groundwater reserves over the next forty years?

The answer cannot simply be that water will somehow be managed.

Communities deserve specifics.

The Air We Will Breathe

Environmental concerns extend well beyond water.

Mining operations generate substantial amounts of dust and particulate matter. Transportation of ore, blasting activities, crushing operations and industrial processing can significantly affect local air quality.

Steel manufacturing presents even greater environmental challenges.

Globally, the steel industry accounts for approximately seven per cent of total carbon dioxide emissions. Modern steel plants have become cleaner and more efficient, but environmental impacts remain substantial unless

advanced technologies are adopted from the outset.

Questions therefore arise regarding the technology that will ultimately be employed in Chiniot.

Will it utilize energy-efficient and low-emission processes?

Will renewable energy become part of its industrial ecosystem?

Will environmental monitoring systems operate independently and transparently?

These questions must be answered before production begins rather than after environmental problems emerge.

Waste Never Truly Disappears
Mining produces more than valuable minerals.

Waste rock, processing residues and industrial by-products remain long after extraction has ended.

Every mining project must answer three fundamental questions.

Where will waste materials be disposed of?

How will they be monitored?

Who remains responsible decades after commercial operations conclude?

International experience demonstrates that inadequate waste management can become one of mining's most expensive and environmentally damaging legacies.

Pakistan need not travel abroad for examples. Environmental and social assessments prepared for large mining projects such as Reko Diq devote substantial attention to tailings management, groundwater protection, biodiversity impacts, cumulative environmental effects and mine closure planning.

Chiniot deserves no less.

Environmental safeguards should never be treated as obstacles to development. They are essential components of responsible development.

Development Without Communities Is Not Development

Environmental debates often focus exclusively upon pollution.

Communities must not be forgotten.

Land acquisition, transportation corridors, industrial infrastructure and changing patterns of economic activity inevitably affect local populations.

Will local residents become beneficiaries or merely spectators?

Will technical training programmes prepare local youth for employment opportunities?

Will local businesses become part of the supply chain?

Will environmental monitoring

reports become publicly available?

These are not political questions.

They are questions of engineering ethics and sustainable development.

Industrialization succeeds only when communities become stakeholders rather than casualties of progress.

The Missing Conversation

Perhaps the most troubling aspect of the public debate surrounding Chiniot is what remains absent from it.

We hear estimates worth billions of dollars.

We hear projections of economic transformation.

We hear promises of industrial revival.

What we hear far less frequently are discussions about environmental carrying capacity, groundwater modeling, emissions management, mine closure plans, biodiversity protection and community participation.

No major industrial project in the twenty-first century can afford to treat environmental questions as secondary considerations.

The world's most successful mining economies no longer ask whether development should occur. They ask how development can occur responsibly.

Pakistan must adopt the same approach.

Progress Must Not Become Pollution

There should be no false choice between economic development and environmental responsibility.

Pakistan needs both.

Chiniot's mineral wealth may indeed transform parts of the country's industrial landscape. Its iron ore and copper deposits appear sufficiently credible to attract international technical interest and serious investment planning.

But mineral wealth alone guarantees nothing.

The true measure of success will not merely be how many tonnes of steel emerge from Chiniot. It will also be measured by whether future generations inherit cleaner industries, protected water resources and prosperous communities—or whether they inherit environmental liabilities created in the name of progress.

Economic benefits are usually calculated before projects begin.

Environmental costs are often calculated afterwards.

The time to ask who will pay those costs is now—not forty years later. ■

Mari Energies Awards Third-Party Gas Sale Contract for Spinwam Discovery

Mari Energies Limited has awarded the contract for the sale of natural gas from its Spinwam Gas Discovery in Khyber Pakhtunkhwa, marking another step towards commercializing one of the country's recent hydrocarbon discoveries.

In a notice submitted to the Pakistan Stock Exchange (PSX), the company said it has issued a Letter of Award to Universal Gas Distribution Company (Pvt.) Ltd.

following the successful conclusion of a competitive bidding process launched in May this year.

Under the agreement, Universal Gas Distribution Company will purchase up to 17.5 million standard cubic feet of gas per day (MMscfd) from the Spinwam Gas Discovery.

Mari Energies said both parties will now seek the regulatory approvals and other clearances required under the Framework for Sale of Gas to Third Parties, notified by the federal government through SRO 11(I)/2025 on January 7, 2025. The framework allows exploration and production companies to sell gas directly to third-party buyers under a regulated mechanism.

The company operates the Waziristan Block with a 55 per cent working interest, while Oil and Gas Develop-

ment Company Limited (OGDCL) holds 35 per cent and Orient Petroleum Inc. owns the remaining 10 per cent.

The award comes amid an active exploration phase for Mari Energies, which has emerged as one of Pakistan's most successful exploration and production companies over the past year.

In recent months, the company announced several hydrocarbon discoveries, including the Shams-1 gas and condensate discovery in the Mari Development and Production Lease in Ghotki, Sindh. Testing at the well produced nearly 48 MMscfd

of gas along with condensate from the Lower Goru formation, further strengthening production prospects in the mature Mari field.

Earlier, Mari Energies also reported a significant gas discovery at Soh-1 in the

Sujawal Block, where the exploratory well flowed around 36 MMscfd of gas from the Lower Goru Massive Sand Formation. The company described it as the first-ever gas discovery from the Massive Sands in the area, opening a new exploration play in the basin.

Industry analysts believe the successful commercialization of Spinwam, together with recent discoveries in Sindh, reflects Mari Energies' sustained exploration success at a time when Pakistan is striving to enhance indigenous gas production, reduce reliance on imported LNG, and improve long-term energy security. ■



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Karachi's Water Reforms: Can KWSSIP Finally Deliver What Previous Projects Couldn't?

Sindh and World Bank review progress on Karachi's ambitious water sector transformation program as institutional reforms become as important as infrastructure development

Manzoor Shaikh

Karachi's water crisis has survived governments, development plans and billions of rupees worth of investments. Despite being Pakistan's economic hub, millions of residents continue to struggle with water shortages, unreliable supplies and dependence on water tankers.

Against this backdrop, Sindh Chief Minister Syed Murad Ali Shah and World Bank Country Director Ms Bolormaa Amgaabazar reviewed the Karachi Water and Sewerage Services Improvement Project (KWSSIP) this week. While the meeting highlighted progress on several ongoing initiatives, it also underscored the enormous challenge of reforming one of Pakistan's most troubled public utilities.

Unlike previous water schemes, KWS-SIP is not merely another infrastructure project. It is an ambitious utility reform program designed to transform the Karachi Water and Sewerage Corporation (KW&SC) into a financially sustainable, technologically driven and professionally managed institution.

The program seeks to improve water supply and sanitation services while simultaneously addressing governance, operational

efficiency, financial management and technological modernization.

More Than Water Supply

One of the immediate objectives of the ongoing phase is to provide safe drinking water access to nearly two million Karachi



residents.

Mayor Karachi Barrister Murtaza Wahab informed the meeting that chlorination stations have been shifted to designated locations and commissioning activities are

underway. Water quality testing is expected to commence by July 30.

Chief Minister Murad Shah directed project teams to ensure timely completion of all testing activities and maintain strict water quality standards.

well beyond supply shortages. Ageing infrastructure, leaking pipelines, illegal connections, contamination risks and weak institutional systems have historically prevented available water from reaching consumers efficiently.

Water experts have repeatedly argued that increasing supply alone cannot solve Karachi's problems unless transmission losses and distribution inefficiencies are simultaneously addressed.

Reforming the Utility Itself

Perhaps the most significant development shared during the meeting was that KW&SC has achieved full coverage of its operation and maintenance costs—a major institutional milestone under the reform program.

Financial sustainability remains critical for any public utility seeking long-term improvements in service delivery.

The World Bank-supported reforms are therefore focused not only on infrastructure development but also on strengthening institutional capacity. Digital monitoring systems, hydraulic modelling, GIS-based asset management, pilot metering programs and Supervisory Control and Data Acquisition (SCADA) sys-

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enjoyed it. At the end of the presentation, professionals asked questions about the product.



distributor, in partnership with VESRA (authorized licensee of Honeywell) hosted the grand launch ceremony

Karachi, setting a new standard for sustainable and energy-efficient lighting across residential, commercial and

the chief guest of the ceremony. In his speech he appreciated and welcomed VESRA and Honeywell lighting in the Pakistani market. He said that the government of Pakistan is desperate for foreign investment. The government is improving the procedure for foreign investors. He said, I am happy to inform you that the international rating agencies are improving Pakistan's rating.

Zafar Mirza, Country Sales Manager, VESRA, gave the technical presentation about Honeywell lighting. His presentation is comprehensive and professionals

Zeeshan Khan, CMO, Business IT Solutions, also gave the presentation. His presentation was about the Business IT Solutions, the company's history, divisions and marketing plans.

Shabbir Ahmed, CEO, Business IT Solutions and Omer Ahmed, Head of Lighting, Business IT Solutions were also there for their customers' queries.

Business IT Solutions arranged the Product Showcase in the event. The guests explored Honeywell's latest ultra-efficient LED systems and modern architectural fixtures. - PR

Karachi's Water Reforms:

Contd from page 3

tems are gradually being introduced to modernize Karachi's water utility.

The larger objective is straightforward but ambitious: creating a utility that knows how much water it receives, how much it loses and how much eventually reaches consumers.

Implementation Challenges Persist

Like most mega infrastructure projects, KWSSIP continues to face implementation challenges.

The meeting reviewed progress on compensation payments for project-affected persons, environmental compliance measures and technical works under various project components.

Compensation payments have been completed for 186 out of 203 project-affected persons, while the remaining cases are expected to be resolved after approval of revised resettlement plans.

Murad Shah directed authorities to complete all outstanding compensation matters transparently and without delay.

Meanwhile, an Independent Monitoring Consultant for environmental and social compliance joined the project earlier this month to strengthen oversight mechanisms.

Several unfinished components of KWSSIP-I—including non-revenue water strategies, hydraulic modelling, pilot district metered areas, SCADA installations and water testing activities—are now being transitioned to KWSSIP-II to ensure continuity.

K-IV Remains Strategically Important

Procurement activities for K-IV augmentation have entered an advanced stage, with the World Bank issuing a conditional no-objection

certificate for the project.

K-IV remains one of Karachi's most strategically important water supply initiatives and is expected to significantly strengthen the city's bulk water supply arrangements.

Yet experts caution against viewing K-IV as a standalone solution. Without addressing water losses and distribution inefficiencies, additional supplies may not necessarily translate into better services for consumers.

Karachi's water challenges are both infrastructural and institutional—and both require sustained attention.

The Bigger Picture

Karachi's water crisis has accumulated over several decades and cannot be resolved through a single project or government intervention. The city's growing population continues to place unprecedented pressure on its ageing infrastructure.

The significance of KWSSIP lies precisely in the fact that it attempts to address both infrastructure and institutional weaknesses simultaneously.

Its success will ultimately be measured less by procurement milestones or kilometres of pipelines laid and more by whether Karachi's residents finally receive safe, reliable and affordable water supplies.

The World Bank has reaffirmed its commitment to supporting Karachi's water sector reforms, while the Sindh government has promised continued political support.

For a city of nearly 25 million people, however, the real test remains implementation. Karachi has seen many water projects announced over the years. What its citizens are waiting for now is lasting reform that finally reaches their homes. ■

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FORNIGHTLY ENGINEERING REVIEW

Electricity Pakistan Expo Highlights Pakistan's Expanding Power Engineering Industry

By Hamza Idrees

Pakistan's growing electrical engineering sector came into focus at the Electricity Pakistan Expo in Lahore, where leading local and international companies showcased the latest technologies in power transmission, distribution, renewable energy and electric mobility.

Unlike previous editions that were held jointly with solar exhibitions, this year's event placed its primary focus on the broader electrical engineering industry. The exhibition also featured a dedicated section for electric vehicles (EVs), including electric bikes, charging technologies and related innovations.

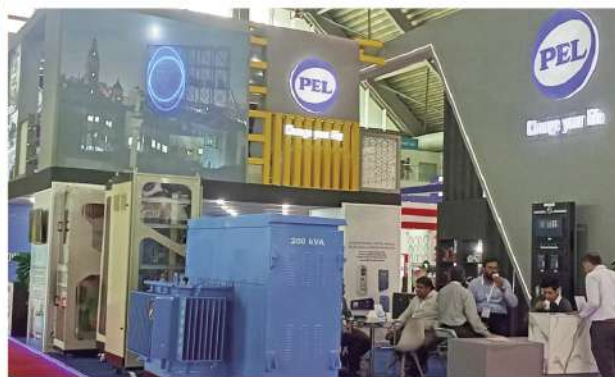
Several leading Pakistani engineering companies attracted significant attention with their products and technological capabilities.

Pak Elektron Limited (PEL) established one of the exhibition's largest and most prominent stalls, displaying its range of electrical appliances, power equipment and energy solu-



tions. Creative Group, Hammad Engineering, Pixel of Faisalabad, Merit Cables, and Electric Power Engineering were among

the major participants, showcasing products ranging from power cables and electrical equipment to solar energy solutions.



A large number of exhibitors also presented advanced solar power products, reflecting the continued demand for renewable

energy technologies despite the exhibition's broader electrical engineering focus.

Among the notable par-

ticipants was Trafolic, a manufacturer of power transformers supplying equipment to WAPDA and other utilities. Company representatives highlighted their locally manufactured transformers designed for Pakistan's transmission and distribution network.

Power Vision also participated in the exhibition, displaying its range of power generation equipment, including industrial generators and backup power solutions for commercial and industrial users.

The expo brought together manufacturers, engineers, distributors, policymakers and investors, providing a platform to explore emerging technologies, strengthen business partnerships and promote indigenous engineering capabilities.

Industry representatives said the exhibition reflects the gradual expansion of Pakistan's electrical engineering sector, particularly in power infrastructure, renewable energy, transmission equipment and electric mobility, while offering local manufacturers an opportunity to demonstrate their technological advancements to domestic and international buyers. ■

Pakistan's Biggest Tech, Career & Startup Exhibition Aptech Learning Pakistan Announces the 16th Edition of Aptech Vision 2026

Aptech Learning Pakistan has officially announced the 16th edition of Aptech Vision 2026 – Pakistan's Biggest Tech, Career & Startup Exhibition, which will take place on 22

together to showcase innovation, explore career opportunities, and build meaningful connections. The 16th edition continues this legacy with its most comprehensive lineup to date.

The event will feature a Software Exhibition showcasing 200-250 student-developed projects in Artificial Intelligence, Cyber-

nizing outstanding freelance professionals; the Visionary Awards, celebrating innovative startups and impactful ideas; and the Alumni Awards, honoring Aptech graduates who have built successful careers through their education and skills.

Another key highlight will be Tech Dialogue Pakistan, themed "Vision 2030: Navigating AI & Cyber Fron-



August 2026, from 10:00 AM to 5:00 PM, at the Pearl Continental Hotel, Karachi.

Aptech Vision has evolved into one of Pakistan's leading technology events, providing a platform where students, startups, freelancers, technology professionals, and industry leaders come

security, Robotics, Web Development, and Mobile Application Development. The Aptech Job Fair, powered by JobGenie, will bring together 50+ leading employers and HR Managers, offering 500+ career opportunities for aspiring professionals.

Aptech Vision 2026 will also host the 2nd Aptech Freelancers Awards, recog-

tioning outstanding freelance professionals; the Visionary Awards, celebrating innovative startups and impactful ideas; and the Alumni Awards, honoring Aptech graduates who have built successful careers through their education and skills.

Aptech Vision 2026 – Pakistan's Biggest Tech, Career & Startup Exhibition is open to the public. Entry is FREE with prior registration through the official Aptech website. - PR

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Sindh to Build Provincial Data Centre to Boost Digital Governance

The Sindh government has decided to establish a state-of-the-art provincial data centre in collaboration with the National Telecommunication Corporation (NTC) to strengthen digital governance, improve data security and accelerate the province's digital trans-

formation. The decision was made during a meeting between Chief Minister Syed Murad Ali Shah and NTC Managing Director retired Major General Ali Farhan at the CM House. Senior officials, including Special Assistant to the Chief Minister on Information Technology Mohammad Ali Rashid, Planning and Development Board Chairman Bilal Memon and NTC representatives, attended the meeting.



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A high-level committee will be formed to prepare a proposal on the project's

specifications, implementation timelines, governance mechanisms and future expansion. He emphasised that government data is a valuable national asset whose protection and efficient management are essential for transparent governance and improved public services.

Murad Ali Shah said the new facility would provide secure data storage, cloud computing and disaster recovery services for government departments while enhancing coordination between institutions. He added that the data centre would support future

initiatives in artificial intelligence, smart governance, digital records management, Safe City projects and citizen-focused services.

The chief minister also highlighted plans to expand high-speed digital connectivity to rural and remote areas, enabling better access to healthcare, education and online government services. The integrated data infrastructure will also strengthen law enforcement through advanced surveillance and real-time data

processing under the Safe Cities initiative.

Briefing the meeting, NTC Managing Director Ali Farhan said the corporation already operates Tier-III compliant data centres in Islamabad, Lahore and Quetta and maintains nearly 1,000 kilometres of optical fibre network across Sindh. He said the proposed Karachi data centre would enhance provincial e-governance, cloud services, cybersecurity and data sovereignty while supporting future digital infrastructure projects across the province. — ERMD

Airlink Enters EV Market with AirV Electric Bike Plant

Airlink Communication Limited has announced plans to establish an electric bike manufacturing plant under its own brand, AirV, as part of its strategy to expand into Pakistan's growing electric mobility sector.

In a notice submitted to

According to the company, the investment is aimed at diversifying its manufacturing portfolio into technology-driven mobility solutions while capitalizing on the rising demand for electric vehicles in Pakistan. The board of directors has

phones, tablets, laptops and other IT and communication products. The company was converted into a public limited company in 2019.

The latest move follows Airlink's efforts to broaden its business beyond consumer electronics. Last year,



the Pakistan Stock Exchange (PSX) on Thursday, the company said the project involves setting up an advanced electric bike assembly plant at its manufacturing facility in the Sundar Green Special Economic Zone (SGSEZ), Lahore.

authorized the management to complete all regulatory, commercial and operational requirements necessary to implement the project.

Founded in 2014, Airlink Communication is one of Pakistan's leading distributors and retailers of smart-

the company approved the establishment of a wholly owned subsidiary, ZEXO Technologies (Private) Limited, with an authorized investment of Rs200 million, as part of its expansion into new technology ventures. — ERMD

Pakistan Invites Samsung to Make Country Regional Smartphone Export Hub

Pakistan has invited South Korean technology giant Samsung to use the country as a regional manufacturing and export base for smartphones, with Commerce Minister Jam Kamal Khan urging the company to expand exports of locally assembled devices to Africa and other emerging markets.

The proposal was made during a meeting between the commerce minister and a Samsung Pakistan delegation led by the company's coun-

The minister also welcomed Samsung's proposal to establish certified mobile phone refurbishment facilities in Pakistan. He said a regulated refurbishment industry would help strengthen local manufacturing, create skilled jobs and open new export opportunities for professionally refurbished devices while providing consumers with quality-assured products backed by warranties.

The Samsung delegation

import of used mobile phones, arguing that such imports undermine local manufacturing despite Pakistan's adequate production capacity. The company proposed replacing used phone imports with a certified refurbishment system under which original equipment manufacturers would establish authorised refurbishment facilities in Pakistan.

Responding to the proposals, Jam Kamal said the government remains commit-



try head. Senior officials from the Ministry of Commerce also attended the meeting, which focused on strengthening Pakistan's mobile phone manufacturing industry and enhancing its role in global supply chains.

Jam Kamal said Pakistan should move beyond meeting domestic demand and leverage its growing manufacturing capacity to become a competitive export hub. He encouraged Samsung to increase exports of Pakistan-made smartphones, saying the country has the potential to attract greater investment through value-added manufacturing and technology transfer.

briefed the minister on the progress of the local mobile phone manufacturing sector and the company's investment in assembly operations. However, it expressed concern over recent changes in the taxation structure, particularly the reduced tariff difference between Semi Knocked Down (SKD) kits and Completely Built Units (CBUs), saying the move has weakened the competitiveness of locally manufactured phones. The delegation urged the government to maintain a reasonable tariff differential to encourage investment and support domestic production.

Samsung also raised concerns over the commercial

ted to promoting genuine manufacturing, localisation, export growth and technology transfer. He directed the industry to submit detailed recommendations on certified refurbishment, export potential, investment plans and international best practices for consideration in the revised Mobile Device Manufacturing Policy. He added that any future incentives would be linked to investment, value addition and exports, reaffirming the government's commitment to developing Pakistan as a competitive manufacturing destination for global technology companies. — ER

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PEC Bets on Leadership and Employability with Two Flagship Initiatives

Chairman Engr. Waseem Nazir's Chartered Project Director certification and Graduate Engineers Trainee Program seek to address two long-standing gaps in Pakistan's engineering profession—project leadership and industry readiness.

For decades, Pakistan's engineering profession has produced thousands of graduates every year, yet two persistent challenges have remained unresolved: the shortage of competent project leadership and the lack of structured transition from university to professional practice.

The Pakistan Engineering Council (PEC) is now attempting to address both through two flagship initiatives launched under Chairman Engr. Waseem Nazir—the Chartered Project Director (Ch.PD) Certification Program and the Graduate Engineers Trainee (GET) Program.

Both Programs stem from Chairman Nazir's belief that Pakistan's engineering sector requires not only technically competent engineers but also project leaders capable of delivering complex infrastructure projects and young graduates equipped with practical skills before entering industry.

Building Project Leaders

The Chartered Project Director (Ch.PD) Program, jointly conducted by PEC and the National Defence University (NDU), is a three-month executive certification designed for experienced engineers responsible for leading strategic development projects.

Unlike conventional project management courses, the Program focuses on leadership, governance, accountability, risk management and decision-making under pressure.

According to PEC, the initiative draws heavily on Chairman Engr. Waseem Nazir's more than four decades of engineering and mega infrastructure experience and seeks to establish a national framework for professional project leadership.

"The Ch.PD is not merely another professional certification; it aims to transform the way Pakistan plans, governs and delivers complex engineering projects," PEC says.

The Program is intended to produce project directors capable of taking ownership of major national projects, strengthening governance and transparency, reducing delays and cost overruns,

minimizing contractual disputes, and delivering infrastructure projects according to internationally recognized standards.

Engineers from Major Organizations Qualify

During the latest passing-out ceremony held at NDU Islamabad, engineers from several leading public-sector organizations successfully earned the Chartered Project Director certification.

Among them were:

Government of Balochistan: Engr. Muhammad Aslam Zehri and Engr. Sami Ullah

Pakistan Airports Authority (PAA): Engr. Faiz Ullah Khattak and Engr. Wasim Ahmed

IESCO: Engr. Asif Ullah and Engr. Muhammad Aasim

Pakistan Atomic Energy Commission (PAEC): Engr. Dr. Hammad Nazir, Engr. Muhammad Umair Ahmad, Engr. Muhammad Zeeshan and Engr. Naveed Izhar

Oil and Gas Development Company

Images shared by PEC from Quetta and other locations show GET trainees working in the field alongside practicing engineers, gaining practical experience through real engineering assignments.

The Ch.PD Program targets experienced engineers responsible for delivering Pakistan's strategic infrastructure, while the GET initiative focuses on preparing fresh graduates for industry.

Taken together, they attempt to strengthen both ends of the engineering profession: creating better project leadership at the top and improving employability at the entry level.

Whether these initiatives achieve long-term success will depend on continued industry participation, institutional support and sustained implementation. However, they reflect an acknowledgement that Pakistan's engineering challenges are no longer confined to technical knowledge alone—they also require stronger leadership, better governance and graduates equipped with the skills demanded by a rapidly changing professional landscape. ■



Limited (OGDCL): Engr. Faisal Mumtaz, Engr. Muhammad Atif Malik and Engr. Muhammad Sarfraz.

Five WAPDA and four PAEC engineers also earn prestigious Chartered Project Director (Ch.PD) Certification.

PEC believes the Program will gradually create a cadre of certified project leaders capable of improving the execution of Pakistan's large public infrastructure projects.

Bridging the Gap Between University and Industry

The second major initiative is the Graduate Engineers Trainee (GET) Program—Pakistan's first structured engineering "house job" Program.

For years, engineering graduates have entered the job market with limited industrial exposure, forcing employers to spend considerable time and resources on practical training.

The GET Program attempts to bridge that gap.

The inaugural batch recently completed six months of training consisting of five months of intensive field placement with industry, and one month of professional development and soft-skills training at NDU.

The Program combines technical exposure with communication, leadership and workplace skills that are increasingly demanded by employers.

Speaking at the passing-out ceremony, Chairman Engr. Waseem Nazir described the Program as the fulfilment of a long-held vision. "When I envisioned the GET Program, I saw an opportunity to transform the transition from university to professional practice. Today, as the first cohort passes out, I feel proud that together we have turned that vision into a lasting reality for Pakistan's young engineers."

Deputy President NDU Rear Admiral Shafaqat Hussain Akhtar also addressed the graduates, encouraging them to contribute towards Pakistan's technological advancement, sustainable infrastructure and national development.

A National Investment

PEC describes the GET Program as more than a training initiative, calling it a national investment in engineering excellence.

Unlike conventional internships, the Program provides structured, supervised industrial training designed to prepare graduates for professional engineering careers before they formally enter the workforce.

Changing the Engineering Landscape
Although still in their early stages, both initiatives represent a notable shift in PEC's approach—from functioning primarily as a regulatory body to becoming an institution actively engaged in professional capacity building.

neering challenges are no longer confined to technical knowledge alone—they also require stronger leadership, better governance and graduates equipped with the skills demanded by a rapidly changing professional landscape. ■

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Agriculture Review



Agriculture Can Transform Pakistan from an Importer into an Export Powerhouse, Says Engr. Jawed Saleem Qureshi

Pakistan can fundamentally transform its economy by modernizing agriculture, improving seed technology and promoting agro-based industrialization, according to Engr. Jawed Saleem Qureshi, Chairman of Four Brothers Group and former Chairman of the Pakistan Engineering Council (PEC).

Addressing the country's first Economic Summit in Islamabad, attended by leading industrialists, policymakers and business leaders, Engr. Qureshi argued that agriculture—not short-term fiscal measures—holds the key to reversing Pakistan's growing import dependence and placing the country on a sustainable export-led growth path.

Drawing on data presented during his address, he maintained that Pakistan possesses the land, climate and human resources to become a regional agricultural powerhouse but has consistently failed to make strategic policy decisions.

The Sector That Once Sustained Pakistan Opening his presentation with a fundamental question, Engr. Qureshi asked:

"The agriculture sector that once enabled Pakistan to stand on its own feet—how did it reach its present condition? My presentation seeks to answer that question."

He cited canola as a successful example of how policy reforms can dramatically improve agricultural performance. According

to him, during the previous government, regulatory approvals for new seed varieties led to remarkable growth in cultivation.

"Canola was previously cultivated on only around 100,000 acres. After the

that timely policy decisions, backed by modern seed technology, can significantly improve productivity and reduce Pakistan's dependence on imports.

An Agricultural Country Importing Food



approval of new high-performing varieties, cultivation has now expanded to nearly 1.2 million acres," he said.

The experience, he argued, demonstrates

Despite being recognized as an agricultural economy, Pakistan continues to spend enormous amounts on importing basic agricultural commodities.

Engr. Qureshi noted that the country currently imports nearly US\$11.19 billion worth of agricultural commodities every year.

Importantly, he pointed out that this figure excludes wheat imports.

"If wheat is included, the annual import bill rises substantially," he said, adding that Pakistan has focused almost exclusively on wheat under the banner of food security while neglecting other equally essential commodities such as soybean, pulses and edible oil crops.

This imbalance, he said, has exposed the country to rising international food prices and increasing pressure on foreign exchange reserves.

Pakistan's Productivity Gap

A major concern highlighted during the presentation was Pakistan's significantly lower crop productivity compared to global averages.

According to the data presented:

- Wheat yield in Pakistan averages 3.2 metric tonnes per hectare, compared to a global average of approximately 8.2 tonnes.
- Rice yields average 6.7 tonnes, while many competing countries achieve 8 to 10 tonnes.
- Cotton productivity stands at only 0.45 tonnes, whereas international competitors often produce 2 tonnes or more.

"This is the real picture of Pakistan's agriculture," Engr. Qureshi observed. The Seed Challenge

He identified poor-quality seed as the single biggest obstacle preventing higher agricultural productivity.

"We simply do not have quality seed," he said.

"Without quality seed there can be no quality production. Farmers will not earn better incomes, industries will remain deprived of raw material, and the economy cannot move forward."

He stressed that agriculture requires timely decisions rather than endless meetings.

According to him, the successful performance of mustard and canola during the 2025-26 season demonstrated what can be achieved when sound decisions are implemented.

"The improvement came because the

right decisions were taken," he said.

A \$7.68 Billion Opportunity

Engr. Qureshi revealed that seven major crops alone currently generate approximately US\$7.68 billion in annual revenue.

He clarified that this figure does not represent the entire agriculture sector but only the principal crops included in his analysis.

With improved seed technology, modern farming practices and strategic policy reforms, he argued, these crops could become the foundation for transforming Pakistan's economy.

"If correct decisions are made, these crops alone have the potential to reshape the country's economic future," he said.

From Raw Commodities to Value Addition

Beyond increasing agricultural production, Engr. Qureshi emphasised the importance of developing agro-processing industries.

"The real money lies in value addition," he said.

Processing agricultural commodities into finished products substantially increases their commercial value while creating employment, industrial investment and export opportunities.

He estimated that through greater value addition and industrial collaboration, Pakistan could potentially replace a significant portion of its agricultural imports and create billions of dollars in additional economic activity.

According to his projections, coordinated efforts between agriculture and industry could generate economic support equivalent to nearly US\$7.68 billion annually while reducing dependence on imports.

A Six-Point Reform Agenda

To unlock agriculture's full economic potential, Engr. Qureshi proposed a comprehensive six-point reform programme aimed at attracting long-term private investment in agro-based industries.

His recommendations included:

- Ten-year tax exemptions for agriculture-related industrial investments.
- Long-term industrial land leases to encourage capital-intensive projects.
- Establishing Special Economic Zones (SEZs) dedicated to agro-processing industries, or alternatively declaring existing agro-industrial clusters as SEZs.
- Creating commodity trading houses to modernise agricultural marketing and improve price discovery.
- Promoting stronger collaboration between agriculture and industry to accelerate value addition.
- Encouraging policy consistency to support long-term investment in seed technology, processing facilities and export-oriented production.

Engineering Solutions for Agricultural Growth

Having led the Pakistan Engineering Council for six years before returning full-time to the private sector, Engr. Qureshi said engineering, research and technology must become central components of agricultural development.

He noted that Four Brothers Group has increasingly focused on agricultural research and seed development, introducing climate-resilient crop varieties designed to improve yields under changing weather conditions.

He argued that engineering expertise, scientific innovation and modern seed technology must work together if Pakistan hopes to compete internationally.

"The future of Pakistan's economy depends not merely on producing more crops, but on producing smarter, processing locally and exporting globally," he concluded. — ER Report

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Chinese Firm, Bahum Global Sign MoU to Boost Pakistan's EV Infrastructure

Star Charge Energy Pakistan, a leading Chinese electric vehicle (EV) charging and digital energy solutions company, and Bahum Global Pakistan have signed a Memorandum of Understanding (MoU) to strengthen Pakistan's electric mobility sector through international collaboration, local manufacturing and technology transfer.

The agreement was signed at a ceremony attended by Special Assistant to the Prime Minister (SAPM) on Industries and Production Haroon Akhtar Khan, who described the partnership as an important step towards industrial modernization, clean energy adoption and sustainable economic growth in line with the government's development agenda.

Speaking at the event, Haroon Akhtar Khan said the government is committed to transforming Pakistan's transport sector by promoting electric

mobility. He said the upcoming Battery Energy Storage System Policy would encourage local manufacturing, attract foreign investment and support the development of a sustainable EV ecosystem in the country.

He said wider adoption of electric

ships with leading Chinese companies would help promote local production of EV batteries, facilitate technology transfer, strengthen domestic industrial capabilities and create employment opportunities for skilled youth. He added that expanding cooperation between Pakistan and China in advanced manufacturing and clean energy technologies would enhance the country's long-term industrial competitiveness.

StarCharge, which ranks among the world's leading EV charging solution providers, has supplied millions of EV chargers globally. In Pakistan, the company, together with partners such as Bahum Global, is supporting the transition to clean energy through EV charging systems as well as solar panels, inverters and battery storage solutions.

The ceremony was attended by senior officials from the Ministry of Industries and Production, representatives of StarCharge Energy Pakistan and Bahum Global, members of the business community and other stakeholders. — ERMD



vehicles would reduce Pakistan's dependence on imported petroleum products, lower the national import bill and contribute to environmental protection and energy security. The government, he added, is also facilitating the establishment of EV charging infrastructure across the country to make electric vehicles more accessible and convenient for consumers.

The SAPM said strategic partner-

Ghandhara Tyre Secures Gulf Certification, Opens Export Access to Six GCC Markets

Ghandhara Tyre and Rubber Company Limited (GTR) has received official approval and certification from the Gulf Standardization Organization (GSO),

United Arab Emirates.

The company described the certification as a significant milestone that will strengthen its export portfolio and support its strategy of expanding into international markets.

GTR stated that the approval reflects its contin-



enabling the company to export its tyre products to six Gulf Cooperation Council (GCC) member states.

In a material information notice submitted to the Pakistan Stock Exchange (PSX), the company said the GSO certification allows GTR Tyres to access the markets of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the

ued commitment to producing tyres that meet internationally recognised quality and safety standards, while reinforcing its position in the global tyre industry.

The company added that it remains focused on enhancing its international presence and delivering high-quality products in compliance with global standards. — ER

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Engineering Review

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Strategic Mapping of Technology Adoption in Engineering Organizations

Engr. Dr. Muhammad Nawaz Iqbal

Adopting technology in engineering organizations needs to be viewed from multiple dimensions, which include aligning technological capability with organizational goals, the operating environment, and long-term competitiveness.

Unlike more conventional implementation plans, strategic mapping sets up a systematic framework featuring key steps in the evolution from conceptual exploration to enterprise-wide integration of technologies. Today, engineering organizations are operating in digitally connected and sustainable ecosystems with ever-changing customer demands. Thus, the implementation of technology needs to be seen as a continuous strategic capability rather than a series of single investments. By using strategic mapping, organizations can establish priorities for technology, create a resource allocation plan, ensure innovation plans are in sync with operational excellence, and remain resilient to future uncertainties.

The first step in the strategic architecture of technology adoption is to align the technology vision with engineering capabilities and the corporate vision. Many times, organizations find that more advanced solutions do not add the value they had hoped for because they are not strategically aligned with the organization's goals. This challenge can be addressed by strategically mapping technology initiatives to measurable business outcomes, engineering performance indicators, and customer value propositions. This alignment ensures that technology becomes an asset rather than merely a means of doing things and contributes to improved productivity, better product quality, and a stronger competitive position. As a result, engineering companies become better equipped to assess technological possibilities in terms of their relevance and not merely their novelty.

An advanced strategic mapping framework also views organizational readiness as

dynamic rather than a one-time requirement. Financial capacity and the availability of the necessary infrastructure are not the only components of readiness; workforce competencies, leadership commitment, organizational culture, and institutional learning capabilities are all part of it. Behavioral change is one aspect of technological change that is often underestimated by engineering organizations. Therefore, strategic mapping visualizes readiness as a continuum—a progressive process in which investments in human capital, knowledge management, and collaborative learning continue to build the organization's ability to absorb advanced technologies. This dynamic view enables decision-makers to identify capability gaps early enough in the implementation process so that risks do not escalate into failure.

However, the complexity of engineering organizations requires strategic mapping to recognize technology adoption as a network phenomenon rather than a departmental effort. Factors such as interconnected design teams, manufacturing systems, supply chain partners, regulatory institutions, and digital platforms work in unison in modern engineering processes. Strategic mapping thus represents the interdependencies among these actors, showing how technological decisions in one functional area affect performance across the organizational ecosystem. This network-based mapping enables coordinated decision-making, reduces technological fragmentation, promotes interoperability among engineering systems, and helps realize seamless organizational transformation across multiple operational layers.

In strategic mapping, knowledge dynamics are further integrated into technology adoption pathways. In addition to learning advanced technologies, innovation in engineering requires building, sharing, and embedding specialized knowledge within the organization. Strategic maps therefore identify knowledge creation nodes, knowledge hubs, collaborative interfaces, and learning feedback mechanisms that enable the continuous evolution of technology.

From this perspective, organizational knowledge is both the key driver and the result of technology adoption. As a result, engineering organizations develop comprehensive technological capabilities that enhance their capacity to innovate and reduce reliance on external sources during future technological transitions.

In the context of digital transformation, engineering organizations are increasingly embracing technological convergence in their strategic mapping rather than pursuing single innovation trajectories. As innovations such as artificial intelligence, digital twins, the Industrial Internet of Things, cloud engineering, additive manufacturing, robotics, and advanced analytics are introduced, the value they create becomes synergistic when effectively adopted. Strategic mapping captures these converging relationships by visualizing technological complementarities, common infrastructure requirements, and cross-functional applications. This integration enables seamless investments and facilitates the development of intelligent operational ecosystems capable of adaptive decision-making, proactive optimization, and autonomous process improvements throughout the engineering value chain.

A more advanced level of strategic mapping involves dealing with uncertainty through adaptive decision architectures. Engineering firms face technologically disruptive environments, fluctuating markets, regulatory changes, and geopolitical challenges. In such situations, static adoption plans quickly become outdated. Strategic mapping therefore incorporates scenario planning, technological forecasting, risk intelligence, and adaptive governance processes that continually recalibrate adoption pathways. Rather than prescribing fixed sequences of implementation, strategic maps are living strategic instruments that adapt to changing organizational priorities and external environmental conditions, thereby improving an organization's strategic resilience over time.

The strategic value of technology adoption becomes significantly more important

when sustainability goals are integrated into the mapping process. Engineering companies are increasingly sensitive to the social and ecological consequences of their activities while also taking economic performance

into account. The strategic evaluation of technologies therefore considers resource efficiency, carbon reduction potential, compatibility with the circular economy, technology life-cycle optimization, and sustainable innovation outcomes. This holistic view helps organizations select technologies that simultaneously improve engineering productivity and environmental sustainability. Technology can therefore be viewed as a strategic tool for securing competitive advantage while proactively addressing evolving regulatory and societal demands.

Strategic mapping also extends beyond organizations and serves as a tool for articulating strategies that enhance innovation and technological success within industrial ecosystems. Engineering firms rarely innovate in isolation; they co-create technologies with suppliers, research institutions, governmental agencies, customers, and technology vendors. Innovation networks, knowledge exchange mechanisms, strategic alliances, and technological dependencies are therefore visualized through strategic mapping to understand how they affect innovation adoption outcomes. Such an ecosystem approach not only enables engineering organizations to benefit from collective intelligence but also helps minimize innovation-related uncertainties, accelerate commercialization, and strengthen technological competitiveness through collective capability-building rather than individual projects. ■



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OGDC Partners with Canadian Firm to Boost Heavy Oil Production Using Advanced Technology

Oil & Gas Development Company Limited (OGDC), Pakistan's largest exploration and production company, has entered into a strategic partnership with Canada's Synergetic Oil Tools Inc. to introduce advanced Passive Energy Tool (PET) technology aimed at increasing production from the country's heavy crude oil reservoirs.

The agreement, signed at OGDC Headquarters in Islamabad, marks another step in the company's efforts to modernise oil recovery operations by adopting international technologies capable of improving production from mature and technically challenging fields.

The contract signing ceremony was attended by Canadian High Commissioner to Pakistan Ambassador Tarik Ali Khan as the chief guest, alongside OGDC Managing Director and CEO Ahmed Hayat Lak. Synergetic Oil Tools President and CEO Brian Herman participated virtually, while senior officials from OGDC, the Canadian High Commission and Synergetic Oil Tools were also present.

Under the agreement, Synergetic will deploy its proprietary Passive Energy Tool technology at selected OGDC heavy oil wells. The technology is designed to improve production by enhancing the flow characteristics of highly viscous crude oil, enabling hydrocarbons to move more efficiently from the reservoir to the

surface.

According to OGDC, the technology offers several operational advantages, including improved flow assurance, reduced well intervention requirements, lower operating costs and decreased dependence on production chemicals. It is also expected to minimise the frequency of costly workovers and reduce well downtime, ultimately improving production efficiency and extending the productive life of heavy oil wells.

Speaking on the occasion, OGDC Managing Director and CEO Ahmed Hayat Lak said the collaboration reflects the company's com-

mitment to introducing innovative technologies to overcome the challenges associated with heavy oil production.

He said Pakistan still possesses considerable untapped hydrocarbon resources in mature fields, but extracting these reserves requires advanced engineering solutions capable of improving recovery while reducing operational costs.

Lak noted that OGDC continues to explore partnerships with leading international technology providers to maximise production, improve operational efficiency and strengthen the country's energy security.

"We remain committed to adopting mod-

ern technologies that improve production performance while reducing operating costs and enhancing recovery from technically challenging reservoirs," he said, expressing confidence that the Passive Energy Tool would significantly improve well productivity and reduce maintenance requirements.

Canadian High Commissioner Ambassador Tarik Ali Khan described the agreement as another milestone in Pakistan-Canada cooperation in the energy sector. He said the partnership demonstrates the growing collaboration between the two countries in advanced energy technologies and critical minerals, adding that Canadian expertise can contribute meaningfully to Pakistan's upstream oil and gas industry.

The collaboration comes at a time when Pakistan is striving to increase indigenous oil production to reduce dependence on imported petroleum products, which

continue to place significant pressure on the country's foreign exchange reserves.

By leveraging international expertise and innovative production technologies, OGDC hopes to unlock greater value from its existing heavy oil assets while supporting the sustainable development of Pakistan's oil and gas sector.

Industry observers believe that if the Passive Energy Tool delivers the expected results, the technology could be deployed across other heavy oil fields in the country, improving recovery rates and reducing production costs over the long term. - ERMD



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پاکستان میں فائبرجی موبائل فون مینوفیکچرنگ میں اضافہ

ملک میں رجسٹرڈ فائبرجی موبائل فونز کی تعداد 38 لاکھ، 10 ہزار تک پہنچ گئی

پاکستان میں مقامی سطح پر فائبرجی موبائل فونز کی مینوفیکچرنگ میں حوصلہ افزا (مینوفیہ) اضافہ ہو گیا جبکہ ملک میں رجسٹرڈ فائبرجی فونز کی تعداد 38 لاکھ 61 ہزار تک پہنچ گئی ہے، جبکہ روزانہ کی بنیاد پر اضافہ ہو رہا ہے۔



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جدید ریلوے معیشت، تجارت، علاقائی روابط بڑھانے میں کلیدی کردار ادا کرے گا، وزیر اعظم

ایم ایل 1 کے روہڑی ملتان سیکشن کی اپ گریڈیشن پر تجاویز دیں، اجلاس سے خطاب، احسن اقبال کی ملاقات، ترقیاتی منصوبوں کی پیشرفت پر غور

60 فیصد کام ہو چکا اور یہ منصوبہ دسمبر 2026 تک مکمل کر لیا جائے گا۔ وزیر اعظم آفس میڈیا ونگ کے بیان کے مطابق وزیر اعظم سے وفاقی وزیر منصوبہ بندی، ترقی و خصوصی اقدامات احسن اقبال نے وزیر اعظم ہاؤس میں ملاقات کی، ملک بھر میں پبلک سیکٹر ڈیولپمنٹ پروگرام سمیت جاری ترقیاتی منصوبوں کی پیش رفت پر تفصیلی تبادلہ خیال کیا گیا۔ وزیر اعظم نے ہدایت کی کہ قومی اہمیت کے تمام ترقیاتی منصوبوں کو اعلیٰ معیار برقرار رکھتے ہوئے مقررہ مدت کے اندر داخلی معیار کے ساتھ مکمل کیا جائے۔ عوامی فلاح و بہبود، روزگار کے مواقع پیدا کرنے اور پائیدار معاشی ترقی کے حصول کے لیے ترقیاتی منصوبوں کی بروقت تکمیل حکومت کی اولین ترجیح ہے۔

متعلقہ حکام نے اجلاس کو بریفنگ دی کہ ایم ایل 1-1 کے کراچی۔روہڑی سیکشن کے لیے تفصیلی انجینئرنگ ڈیزائن مکمل کر لیا گیا ہے۔ جبکہ ایم ایل 3 روہڑی ٹوکندی کی اپ گریڈیشن پنی ایس ڈی پی اور برج فنانسنگ کے تحت کی جائے گی۔ تھرو کول ریل

ادارے کے بنیادی ڈھانچے کی جدید کاری کا پاکستان کی علاقائی تجارت اور لاجسٹکس سب کے طور پر کلیدی کردار ہوگا۔ وزیر اعظم نے ریلوے کے ترقیاتی منصوبوں کو اعلیٰ معیار اور مقررہ مدت کے اندر مکمل کرنے اور مین ریلوے لائنیں ون کے

وزیر اعظم شہباز شریف نے کہا ہے کہ جدید اور موثر ریلوے نظام ملکی معیشت، تجارت اور علاقائی روابط کے فروغ میں کلیدی کردار ادا کرے گا۔ پاکستان ریلویز ٹرانسفارمیشن پلان پر پیش رفت کے جائزہ اجلاس کی صدارت کرتے ہوئے وزیر اعظم کا کہنا تھا کہ پاکستان



ریلوے مسافروں اور مال برداری کے لیے سب سے کم لاگت اور موثر ذریعہ نقل و حمل ہے۔ روہڑی۔ملتان سیکشن کی اپ گریڈیشن کے حوالے سے تجاویز پیش کرنے کی ہدایت کی۔ کن سیٹھی بنی منصوبے کا 112 کلومیٹر طویل ریلوے ٹریک تھرو کول تاجپور ریلوے سٹیشن پر

آٹو انڈسٹری کو برآمدات اور جدت کی راہ اپنانے کی ضرورت

پاکستان کی آٹو صنعت دہائیوں سے درآمدی متبادل پالیسی میں جکڑی رہی، معاشی ماہرین
فضائی صنعت نے عالمی معیار، مقامی پیداوار، برآمدات کے ذریعے کامیابی حاصل کی

پاکستان کی آٹو صنعت کو عالمی سطح پر مسابقتی بنانے کیلئے درآمدی متبادل کی پالیسی ترک کر کے برآمدات پر مبنی حکمت عملی اختیار کرنے کی ضرورت ہے۔ ماہرین کا کہنا ہے کہ فضائی صنعت، خصوصاً جے ایف 17 تھنڈر طیارے کی کامیابی اس بات کا ثبوت ہے کہ جدت، معیار اور عالمی ویلیو چینز سے وابستگی کے ذریعے پاکستان بین الاقوامی سطح پر نمایاں مقام حاصل کر سکتا ہے۔

پاکستان میں 1950 کی دہائی سے گاڑیوں کی اسمبلنگ ہو رہی ہے، تاہم آٹو صنعت عالمی منڈی میں اپنی جگہ بنانے میں ناکام رہی ہے۔ اس کے برعکس چین کے اشتراک سے تیار کیے جانے والے جے ایف 17 تھنڈر کے تقریباً 60 فیصد پرزے پاکستان میں تیار کیے جاتے ہیں، جس کے باعث ملک کو اس کی تیاری، دیکھ بھال اور مستقبل میں مزید ترقی پر خاطر خواہ اختیار حاصل ہے۔

رپورٹ میں لکھا گیا کہ جے ایف 17 کی قیمت 2 کروڑ 50 لاکھ سے 4 کروڑ ڈالر کے درمیان ہے، جو رافیل، یوروفائٹر اور ایف 16 جیسے طیاروں کے مقابلے میں کہیں کم ہے، طیارے کو عالمی فضائی نمائندوں میں پذیرائی حاصل ہوئی ہے اور متعدد ممالک اس کی خریداری میں دلچسپی ظاہر کر چکے ہیں۔ ماہرین کے مطابق آٹو صنعت کو برسوں تک حکومتی تحفظ

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Turning molecules into reliable electronic devices with a new fabrication platform

Molecules are among the smallest building blocks available for making next-generation devices. Their unique, customizable properties enable promising applications in emerging computing, sensing, optical and quantum technologies.

But integrating molecules into functional devices at scale remains a challenge. Traditional semiconductor manufacturing processes can damage small, fragile molecular materials. Now, MIT researchers have developed a scalable fabrication technique that incorporates delicate molecular materials into electronic devices on a chip without causing damage.

Their method extends the capabilities of

that were previously infeasible," says Farnaz Niroui, an associate professor of electrical engineering and computer science (EECS), a member of the Research Laboratory of Electronics (RLE), and senior author of a new paper describing the work published in *Nature Nanotechnology*.

Building with molecules

Molecules are small clusters of atoms with structures and chemistries that can be precisely designed. This allows their properties to be engineered across a wide design space.

Once integrated into device architectures, these molecules could enable next-generation electronics and computing platforms that are smaller, faster and more adaptable, as well as higher-performance photonic devices and emerging quantum technologies.

To build a functional system, molecular

main device elements, it allows us to use conventional processes that are normally not compatible with these nanomaterials," Satterthwaite says.

In their demonstration, the researchers fabricated a scaffold with two metal electrodes separated by a precisely sized gap. Then, they deposited the molecular layer on the electrode surfaces.

Finally, the researchers leveraged nanoscale forces to gently pull the top electrode onto the molecules, forming the final device in a nondestructive way. This creates a self-aligned, damage-free electrical contact to the molecules.

Using the forces

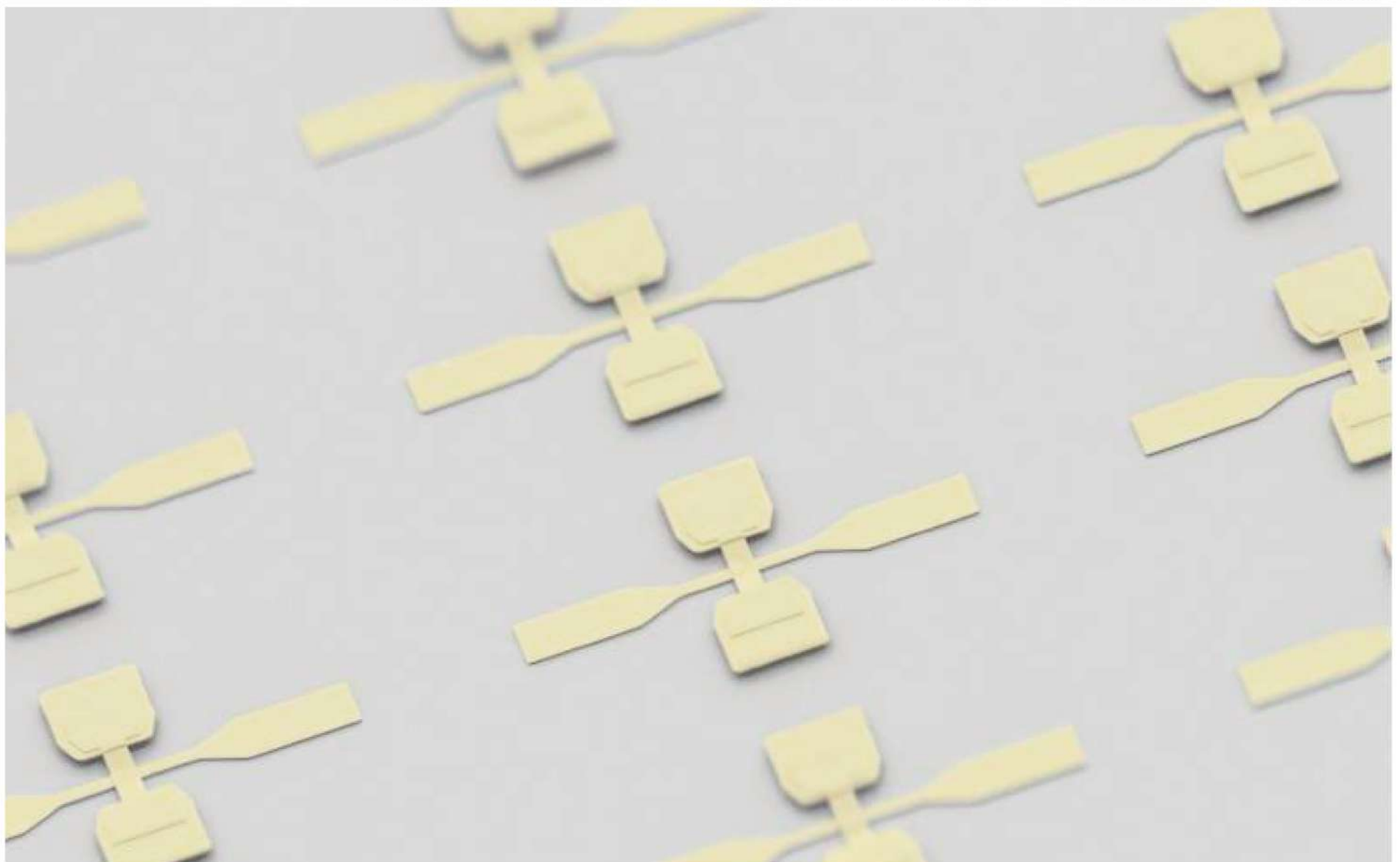
While gravity is a dominant physical force that holds our world together, different forces dominate at the nanoscale. One, called capillary force, causes liquid to get sucked

the structures we ultimately want, we make something mechanically mobile and use forces to transform it into an architecture that would otherwise be impossible to fabricate," Spector explains.

They used this technique to fabricate more than 1,000 devices with molecular layers less than 1 nanometer thick. Even at this tiny scale, the fabricated chips had a high yield of working devices, 96% on average. The robust devices also endured tens of thousands of electrical cycles without showing any sign of degradation.

"The stability really stands out. This is a critical feature for moving molecular devices toward practical applications, but it has been a persistent challenge in the field," Satterthwaite says.

Importantly, this versatile technique allows circuit- and system-level integration



standard semiconductor manufacturing processes to accommodate molecules. The researchers first prefabricate the device components using traditional processes. Then, they introduce the molecules and harness nanoscale surface forces to mechanically transform the fabricated device, which self-assembles without damaging the molecules.

The team demonstrated the robustness and scalability of their technique by fabricating more than 1,000 devices using sub-nanometer molecular layers.

"Our platform combines the scalability of conventional semiconductor manufacturing with the precision and control of self-assembly. This establishes a new fabrication framework for the scalable, high-throughput integration of emerging nanoscale and quantum materials, including molecules, into functional devices with architectures and capabilities

building blocks need to be integrated with other device layers. In electronic systems, a critical step is making electrical contacts to the molecules by interfacing them with metallic surfaces. However, the harsh chemicals and processes needed for traditional chip manufacturing damage these fragile molecular materials, reducing reliability and performance.

To leverage the scalability of standard fabrication techniques while achieving the precision needed for handling molecules, the MIT researchers developed a decoupled, two-step approach.

They first fabricate all the device components using standard semiconductor manufacturing, then incorporate the molecular material after the fact to finish building the device.

"By bringing the delicate materials into the process only after we have fabricated the

into small spaces. (Plants rely on capillary forces to draw water into their stems.)

By carefully engineering the stiffness of the electrodes, when the solution containing the molecules evaporates, capillary forces gently pull the two metal surfaces together with the molecules sandwiched in between.

Once the two electrodes are in place, the researchers must hold them in a stable state. To do so, they rely on another nanoscale force known as the van der Waals force.

Van der Waals forces cause surfaces to attract one another. By controlling the device surface area and molecules' properties, the researchers ensure these forces will be strong enough to hold the electrodes in a stable structure without damaging the molecules.

"Nanoscale forces play a critical role in our approach. Instead of fabricating exactly

of molecular devices, pushing the field beyond the study of isolated devices, the researchers say. They demonstrated this by building an interconnected array of molecular memory devices that could have applications in next-generation computing platforms.

Their technique can also be extended to other materials and device architectures.

In the future, the researchers want to build on this platform to investigate and develop new classes of multifunctional computing and sensing devices and systems.

"By enabling the pristine integration of emerging molecular materials and other atomic-scale matter into functional devices at scale, our platform accelerates discovery and design of these materials with tailored functionalities and their deployment in emerging technologies," Niroui adds. - TX

Organic liquid system could convert dirty factory exhaust into key fuel ingredient without CO₂ purification

A team of international researchers has found a way to turn carbon dioxide from industrial emissions directly into a key fuel ingredient without first cleaning or purifying the gas.

The study, published in *Nature Communications*, overcomes one of the biggest challenges facing carbon capture technologies: the complex mix of gases found in industrial flue gas, a major source of global CO₂ emissions.

A team led by the Université de Montpellier and the University of Adelaide has developed a system that uses a special organic liquid to efficiently convert CO₂ from industrial emissions into carbon monoxide (CO), a key building block used to manufacture fuels and chemicals.

Flue gas has been the obstacle

Industrial flue gas typically contains only small amounts of CO₂ alongside large quantities of nitrogen and oxygen. These impurities have long hindered efforts to convert captured carbon into useful products because they trigger competing chemical reactions that reduce efficiency.

Most existing carbon capture technolo-

gies require CO₂ to be separated and purified before it can be converted into useful products, making the process costly and energy-intensive.

University of Adelaide chemical engineering dean Yan Jiao said the team developed an organic solvent mixture that weak-

ens hydrogen bonding, suppressing unwanted side reactions while favoring CO₂ conversion.

"Our work shows it is possible to use CO₂ directly from industrial exhaust streams without extensive purification, making car-

bon utilization much more practical and potentially more economical," Jiao said. "This could help heavy industries such as steel, alumina refining, cement, chemicals and energy production move toward cleaner and more circular production."

High selectivity and steady performance

the most competitive direct carbon capture and conversion approaches reported to date.

The technology also demonstrated strong durability, operating continuously for more than 100 hours while maintaining high performance.

To explore its renewable energy poten-

tial, the team coupled the system with a high-efficiency solar cell. The integrated setup achieved a solar-to-fuel efficiency of approximately 5.5%, comparable to many systems that rely on purified CO₂ feedstocks.

A route toward cleaner industry

Dr. Damien Voiry of the Université de Montpellier said the findings highlight a promising pathway for transforming industrial emissions into valuable products while reducing the need for energy-intensive carbon capture infrastructure.

"We found that controlling hydrogen-bond interactions is the key to suppressing unwanted reactions and enabling highly selective carbon dioxide conver-

sion," Voiry said.

"This opens a new direction for carbon utilization technologies and could help accelerate the transition toward sustainable fuel and chemical production powered by renewable energy." - TX

Muscle radar unlocks potential for future robotic limbs

University of Queensland researchers have developed new noninvasive

sensors that measure muscle forces, unlocking new possibilities for wearable robotic mobility devices. Ultra-wideband radar sensors measure electromagnetic changes in muscles as they contract, allowing researchers to collect data in a way that's never been done before.

The study is published in the journal *Science Robotics*.

Ph.D. candidate Christopher Bird, who led the research, said the sensors have the potential for several applications, including robotic or prosthetic devices.

"Up until now there hasn't been a way to accurately measure the mechanical forces being produced by muscles when they contract without invasive procedures," Bird said.

"When we use a robotic or prosthetic device to help people move, say, in motor neuron disease or aging, we want to know

when that device should give the person assistance and how much it should give.

"But our current exoskeletons typically rely on external measures to determine

Ultra-wideband radar antennas, which sit on the skin, send electromagnetic pulses into the muscles and record how the transmitted and reflected signals change as the

forces opens exciting possibilities for rehabilitation, injury prevention and recovery, and aged care.

"In some rehabilitation scenarios, electrical currents are used to stimulate muscles in people who have lost voluntary control, but muscles can fatigue quickly and tissue can be damaged," Dr. Dick said.

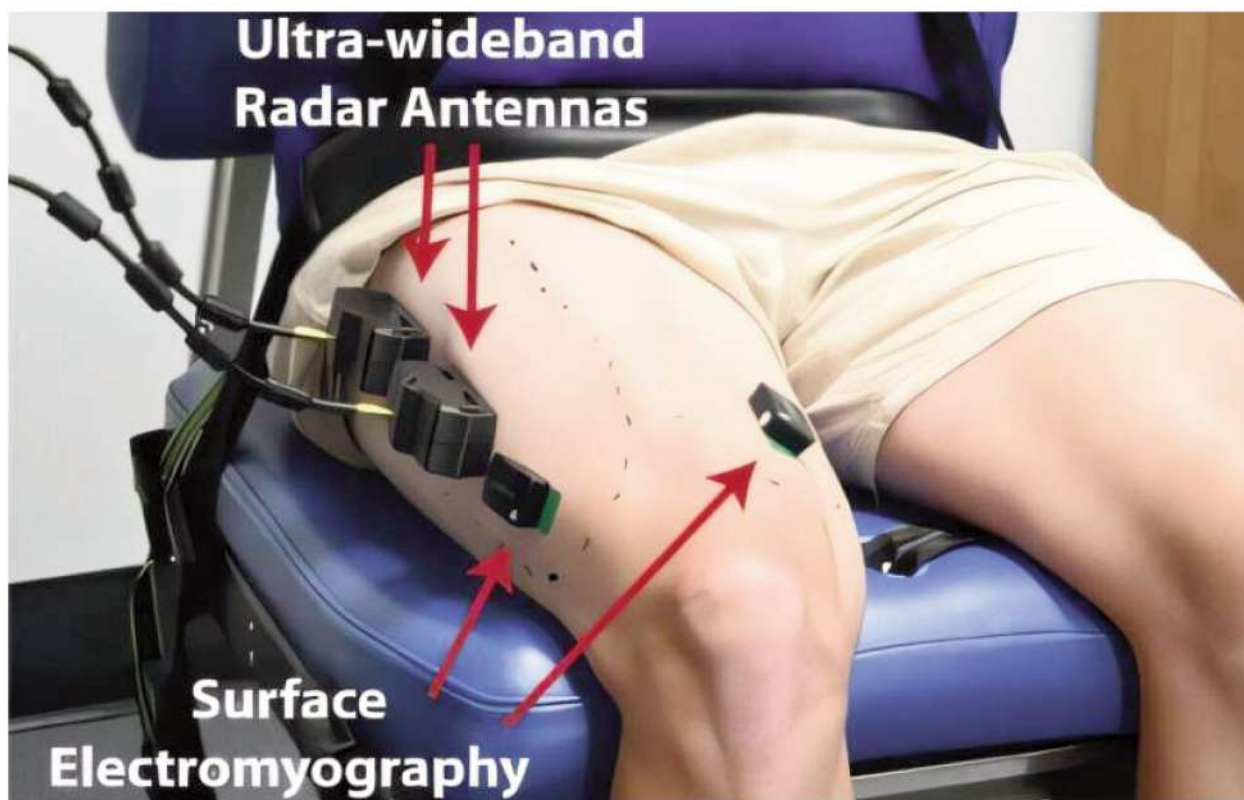
"Until now, there's been no tool to measure how or when that damage will occur.

"There are enormous benefits with this technology—it could help injured athletes accurately determine the best time to return to training with a lower risk of reinjury, and clinicians and patients can be better informed before surgical or rehabilitative decisions are made."

Real-time control is the next step

The goal now is to eventually have the sensors measure forces in real time, allowing them to be used as an input for assistive devices.

"Having a real-time sensor calculating the forces being produced under the skin, telling a device when it should be providing assistance, that's an exciting development," Mr Bird said. - TX



when and what support is needed.

"The results were better than I had hoped for."

How the sensors read muscle force

muscle contracts.

Associate Professor Taylor Dick from UQ's School of Biomedical Sciences said having accurate measurements of muscle