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 1975 - 2025

Founded by **Najam ul Hassan** (Marhoom)
 Vol.51 No. 10 May 16-31, 2026
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Govt Plans Rs25bn Maritime Education Fund to Develop Skilled Workforce for Blue Economy

The federal government is moving ahead with plans to establish a long-term Maritime Educational Endowment Fund aimed at expanding access to maritime education, professional training, and technical skill development for thousands of Pakistani students as part of efforts to strengthen the country's growing blue economy.

The proposed initiative was reviewed during a

meeting chaired by Muhammad Junaid Anwar Chaudhry on Friday, where officials discussed the structure, financing mechanism, and long-term sustainability model of the fund.

According to preliminary estimates shared during the meeting, the Maritime Educational Endowment Fund could generate a scholarship corpus of nearly Rs25 billion over the next decade, while cumulative scholarship and educational disbursements are expected to reach approximately Rs12 billion. The initiative is projected to benefit nearly 65,000 students across Pakistan.

Officials said the fund is being designed as a self-sustaining financial platform that will support not only academic scholarships but also professional and technical training linked to the maritime sector,

including marine engineering, logistics, port operations, shipping management, warehousing, and maritime technologies.

Speaking during the meeting, the federal minister described the initiative as an

important step toward building a modern and skilled maritime workforce capable of meeting the demands of the global blue economy.

He said the government aims to consolidate fragmented educational support mechanisms into a single investment-based model that can ensure long-term sustainability through capital growth, reinvestment, and institutional partnerships.

"The maritime sector requires trained human resources, technical expertise, and modern professional skills," the minister said, adding that the proposed fund

would help prepare Pakistani youth for employment opportunities in ports, shipping, logistics, marine engineering, and other maritime industries.

The meeting was informed that the initiative would also help strengthen capacity-building and workforce development in emerging maritime sectors, which are becoming increasingly important amid global expansion in trade, logistics, and marine transportation.

A briefing presented by Noorul Haq Baloch revealed that two preparatory meetings had already been held to final-

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Govt Plans Rs25bn Maritime Education Fund to Develop Skilled Workforce for Blue Economy

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ize the operational framework of the fund. Officials said the proposed structure includes a 10-member governing board comprising representatives from both the public and private sectors, with an emphasis on gender-inclusive participation.

Senior representatives from Karachi Port Trust, Port Qasim Authority, Gwadar Port Authority and Pakistan National Shipping Corporation attended the meeting along with officials from the Ministry of Maritime Affairs.

The minister said the fund would initially be financed

through corporate social responsibility (CSR) contributions from major maritime institutions and support from private-sector organizations. Participants estimated that private contributions could initially reach around Rs150 million.

Officials informed the meeting that CSR inflows in the first year alone are expected to reach approximately Rs2.35 billion, enabling scholarship and training disbursements of nearly Rs285 million.

Under the proposed framework, about 80 percent of the fund will be allocated for scholarships, professional education, technical training, and capacity-building programs, while nearly 10 percent will be reserved for administrative and operational expenses.

The meeting also discussed the growing need for Pakistan to invest in maritime-related technical skills and engineering expertise in view of expanding regional trade, port modernization projects, and logistics infrastructure development linked to the country's strategic coastline.

Officials observed that global maritime industries are increasingly demanding expertise in areas such as marine engineering, digital logistics systems, supply chain management, ship operations, renewable maritime technologies, and port automation. They noted that Pakistan must invest in specialized education and training to compete effectively in the evolving international maritime economy.

The federal minister said the initiative reflects the government's broader vision of empowering youth through education and practical skill development while creating employment opportunities in the maritime sector.

He added that strengthening maritime education and technical capacity would not only support economic growth but also help Pakistan fully utilize the potential of its ports, shipping industry, and coastal resources in the years ahead. - ER

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Sindh CM Invites Chinese Investment in Digital Economy and Industrial Growth

Syed Murad Ali Shah has invited Chinese companies to invest in Sindh's digital econo-

my, industrial infrastructure, and access to regional and international markets for foreign investors. He described Karachi as Pakistan's economic and logistics gateway and said the provincial gov-

ernment aims to transform the city into a regional center for digital trade, smart logistics, industrial innovation, and export-led growth.



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ernment aims to transform the city into a regional center for digital trade, smart logistics, industrial innovation, and export-led growth.

The chief minister made these remarks while meeting a 32-member delegation of Chinese investors and representatives of Beijing United Information Technology Company Limited (IBI) at the Chief Minister House. The delegation included business leaders from sectors such as industrial internet services, digital supply chains, logistics, petrochemicals, renewable energy, textiles, machinery, and infrastructure development.

Addressing the gathering, Murad Ali Shah said that Sindh, particularly Karachi, offers unmatched connecti-

ties for assembly plants and participation in Sindh's infrastructure and development projects. Energy sector representatives reviewed potential cooperation in renewable en-

meetings, industrial visits, and project feasibility studies. A joint working group comprising representatives from the Sindh Investment Department and IBI was also formed to

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Tribute to Engr. Syed Imtiaz Hussain Shah

Engineers Pay Tribute to Late PEF Leader Imtiaz Hussain Shah at IEP Karachi

A condolence meeting was held at the Institution of Engineers Pakistan (IEP) Centre Karachi to pay tribute to renowned engineer and former president of the Pakistan Engineers Forum (PEF), Imtiaz Hussain Shah, whose passing has left the engineering community in deep sorrow.

Engineers, colleagues, friends, and family members gathered to remember his lifelong contributions to the engineering profession, his principled politics within engineering institutions, and his warm and humble personality.

Speaking on the occasion, Al Kazim Mansoor said that engineers from Multan and across the country shared longstanding friendships with Imtiaz Shah. He recalled contesting several Pakistan Engineering Council (PEC) elections alongside him and former PEC chairman Abdul Qadir Shah, saying their relationship remained strong regardless of political circumstances.

"He was a man no one could remain upset with," Mansoor said emotionally. He recalled that Imtiaz Shah had even reserved a room for him in his Lahore residence, reflecting the deep bonds he maintained with friends and colleagues.

Mansoor noted that although Imtiaz Shah loved participating in elections, he was never obsessed with winning. Recalling one PEC election, he said that when the PEF leadership decid-

ed to withdraw from a coalition despite being in a strong position, Imtiaz Shah immediately accepted the collective decision without hesitation.

"He always stood by his principles and his companions," he said, adding that only memories now remain of a man deeply respected across engineering circles.



Former Pakistan Engineering Council chairman Abdul Qadir Shah described Imtiaz Shah as "like a brother" and said they spent much of their professional and political lives together.

"He was a truthful and sincere person who fulfilled every promise he made," Qadir Shah said. "He spoke plainly, stood firmly by his com-

mitments, and was an excellent friend and human being. His passing has deeply shocked all of us."

Sohail Bashir said Imtiaz Shah commanded respect across all groups within the engineering community regardless of political affiliations.

"He lived a full and meaningful life,"

everyone united. He prayed for the departed soul and said his absence would be deeply felt within the engineering fraternity.

Member Governing Body PEC Amir Zamir said Imtiaz Shah fought elections not for personal victory but for principles and values.

"Most people contest elections only to win, but he was different," Zamir said. "He used to tell me that he contested elections for principles." He added that Imtiaz Shah respected even his political opponents and had set a high moral standard in institutional politics.

Former IEP president Farhat Adil remembered him as "a friend of friends" who maintained warm relationships beyond organizational politics.

Imtiaz Shah's son, Hassan Shah, said his father may have left this world physically, but he continues to live in the hearts of family members, friends, and colleagues.

"I had never seen his friends so grief-stricken before," he said. "Only after his passing did I realize how much silent work he had done for people." He described his father as a unique and caring parent who never refused help to anyone and whose memories would continue to inspire the family.

Participants at the condolence reference offered prayers for the departed soul and remembered Imtiaz Hussain Shah as a principled engineer, a loyal friend, and a respected leader who devoted his life to the engineering profession and institutional integrity. ■



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By: Muhammad Tariq Haq

The New Benchmark in Lean Burn Gas Power Generation Single-Step Load Acceptance Capability Cummins HSK78 — Where Gas Efficiency Meets Diesel Muscle

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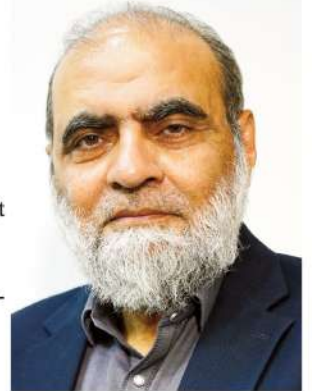
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NHA to Expedite Key Highway Projects Amid Provincial Delays

Abdul Aleem Khan on Friday directed the National Highway Authority (NHA) to accelerate the completion of major road infrastructure projects across the country, warning that delays in development schemes would no longer be tolerated.

Chairing an NHA review meeting in Islamabad on May 15, 2026, the federal minister expressed dissatisfaction over the slow progress of projects involving the governments of Punjab and Khyber Pakhtunkhwa, saying delays were affecting the timely completion of vital transport corridors.

During the meeting, Abdul Aleem Khan particularly referred to the Peshawar Northern Bypass project, stating that despite waiting more than five months for financial commitments from the Khyber Pakhtunkhwa government, no significant progress had been made. He said the NHA was now prepared to complete the project independently if the provincial government failed to pro-

vide the required funds.

The minister also pointed to delays in the Rawalpindi-Kahuta road project, observing that the Punjab government had not yet fulfilled its promised financial contribution. He directed the NHA to assume full responsibility for

pleted with full accuracy and transparency.

The minister further directed that the remaining construction work, particularly bridges on the Peshawar Northern Bypass, should be completed before the start of the July monsoon season to prevent disruptions and possible damage caused by heavy rains.

The meeting was attended by senior officials, including the Secretary Communications and

completing the unfinished sections of the project to avoid further delays.

In addition to addressing pending projects, the communications minister ordered the expansion of the motorway network in Punjab. He directed authorities to widen the Lahore-Sialkot Motorway from four lanes to six lanes and instructed that the Sialkot-Kharian and Kharian-Rawalpindi sections should also be constructed as six-lane motorways.

Abdul Aleem Khan emphasized that all NHA projects must meet strict technical and construction standards. He instructed officials to ensure that project feasibility studies are com-

pleting the unfinished sections of the project to avoid further delays. During the session, the minister reiterated the federal government's commitment to improving the country's transport infrastructure and stressed that fast-track completion of national highway projects would remain a top priority.

Officials briefed the meeting on the progress of ongoing projects, future expansion plans, and challenges being faced in land acquisition, funding, and execution. The minister directed the concerned departments to remove bottlenecks and ensure timely delivery of all strategic road infrastructure projects across the country. - ERMD



Engr. Prof. Dr. Aneel Kumar Honored by University of Oradea, Romania

Aneel Kumar, Pro-Vice Chancellor and Meritorious Professor at the Department of Civil Engineering, Mehran University of Engineering and Tech-

academic and research contributions.

According to the diploma issued by the Romanian university, the honor was conferred upon Dr. Aneel Kumar for his three decades of teaching and research achievements in diversified

The university also acknowledged his efforts in promoting global academic cooperation and strengthening collaboration between international universities.

The diploma was issued in Oradea on May 6, 2026, and was signed by Rector Prof. Dr. Constantin Bungău



nology, has been awarded the title of "Invited Professor, Associate at University of Oradea" by University of Oradea in recognition of his outstanding

fields including sub-soil investigations, shallow and deep foundation design, mechanical and chemical soil stabilization, contamination migration through porous media, and eco-friendly sustainable construction materials.

and President of the Senate Associate Professor Dr. Aurel Căuș.

Academicians and engineers have termed the recognition a matter of pride for Pakistan and especially for the engineering community of Sindh. ERMD

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The Green Gold: Pakistan's Harvest of the Future

By: Adnan Riaz

In the quiet stretches of Khairpur and the lush plains of Sindh, a revolution is brewing—one that doesn't smell of diesel or chemicals, but of sun-dried earth and harvested fiber.

For generations, the Pakistani farmer has looked at the leftover stalks of a banana harvest or the fallen fronds of a date palm with a heavy heart. To them, it was "waste"—a burden to be cleared, often through fire that choked the very air their children breathed. But today, the narrative is shifting. Imagine a world where that same "trash" is transformed into the dashboard of a luxury electric car in Germany, or the structural walls of a sustainable home in Dubai.

We are no longer just an agricultural nation; we are standing on the cusp of becoming a global powerhouse in Bio-Composites.

Waste to Wealth

The concept is simple but profound: taking nature's toughest fibers and marrying them with polymers to create materials that are stronger than wood and lighter than steel. In Pakistan, we aren't just looking for industrial solutions; we are turning Waste into Gold.

- **The Resource Goldmine:** With over 40,000 hectares of banana cultivation and a world-leading date palm industry, Pakistan produces millions of tons of natural fiber annually. This isn't just biomass; it is a strategic reserve of "Green Steel" waiting to be tapped.

- **The TDAP Catalyst:** Recognizing this potential, the Trade Development Authority of Pakistan (TDAP) has taken the lead. During the

landmark 2nd Sukkur Trade Exhibition earlier this year, TDAP's workshops and seminars proved that Sukkur is the natural heartbeat of this industry. By connecting local growers with global trade

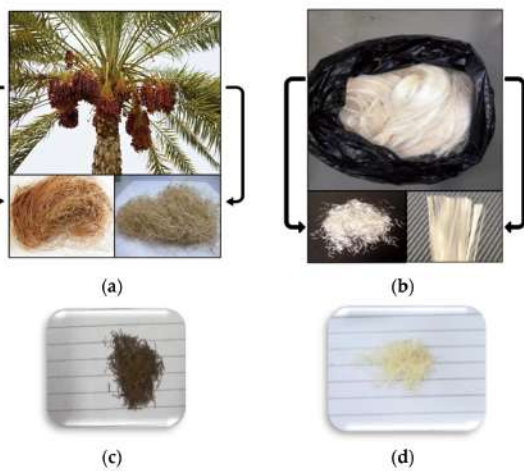


standards, they have laid the roadmap for a "Made in Pakistan" bio-material brand.

A Universe of Opportunity

This isn't just a win for the environment; it's a blueprint for economic prosperity across every level of society:

- **For the Farmer:** The "burden" of agri-



cultural waste becomes a second paycheck. By selling pseudostems and fronds to processing units, farmers transform their harvest leftovers

into a reliable revenue stream, empowering rural communities.

- **For the Student & Researcher:** The field of Bio-Composites is the new frontier of Materials Science. There is a desperate need for young minds to innovate, test, and standardize these materials. It's an invitation to move beyond the textbook and into the lab to solve real-world climate problems.

- **For the Startup & Entrepreneur:** The barriers to entry are falling. From small-scale fiber extraction units to specialized manufacturing for

resources, is the ideal partner for the next generation of global supply chains.

Why Now?

The timing couldn't be more critical. The global biocomposites market is projected to sky-

rocket to over \$45 billion by late 2026.

In the EU, the shift toward a Circular Economy means that synthetic, non-recyclable materials are being phased out. Major automotive and construction giants are no longer just "interested" in bio-composites—they are legally and economically incentivized to find them. Pakistan sits at a unique geographical and economic vantage point to fill this vacuum.

Our Legacy, Reimagined

Engineering is often seen as a cold world of metal and oil. But the Bio-Composite revolution is different. It is an emotional homecoming. It's about taking the very soil we walk on and the plants we nurture, and turning them into the high-tech solutions of tomorrow.

We have the talent. And now, thanks to initiatives like those in Sukkur, we have the momentum. The question isn't whether the world will adopt bio-composites—it's whether Pakistan will be the one

to supply them.

The future isn't just being built; it's being grown. (FIBERCAST: www.fibercast.com.pk) ■



Wood-Plastic Composites (WPC), the "Green Startup" ecosystem in Pakistan is wide open for those brave enough to lead.

- **For the Global Business:** The world is hungry for sustainable alternatives. As the European Union (EU) implements stricter "Green



Deal" regulations and carbon taxes, global manufacturers are scrambling for bio-based materials. Pakistan, with its low labor costs and vast raw

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Agriculture Review



PATCO Seeds Gets NSDRA Approval as Certified Seed Business Enterprise

In a major development for Pakistan's agriculture and seed sector, Pakistan Agricultural Research Council (PARC) has achieved a significant milestone as its initiative, PATCO Seeds, received formal approval as a Seed Business Enterprise from the National Seed Development and Regulatory Authority (NSDRA).

The approval is being seen as an important step toward strengthening Pakistan's seed industry and ensuring the availability of certified, high-quality seeds to farmers across the country.

Rana Tanveer Hussain said the recognition of PATCO Seeds reflects the government's commitment to modernizing agriculture through innovation, institutional reforms, and stronger engagement with the private

sector. He stated that the initiative would help transform Pakistan's agriculture into a more resilient, competitive, and sustainable sector.

The federal minister emphasized that the government is focused on empowering national research institutions to deliver practical agricultural innovations directly to farmers while improving food security and farm productivity.

Under the ministry's policy direction, PARC has introduced several initiatives aimed at strengthening institutional capacity, promoting public-private partnerships, and encouraging investment in agribusiness and seed technology. Officials said these efforts are designed to bridge the gap between agricultural research and commercial application.

The approval of PATCO Seeds marks a key achievement in PARC's commercialization strategy. As a certified Seed Business Enterprise, PATCO Seeds will



now be able to expand its role in the production, processing, and distribution of certified seed varieties across Pakistan.

Chairman PARC Syed Murtaza Hassan Andrabi welcomed the development and described it as a milestone in linking scientific research with practical farming solutions. He said PATCO Seeds would serve as an important platform for transferring modern agricul-

tural technologies and improved seed varieties to farmers.

According to PARC officials, PATCO Seeds will focus on supplying climate-resilient and high-yield seed varieties suitable for different agro-ecological regions of Pakistan. The initiative is also expected to contribute to higher agricultural productivity, improved rural livelihoods, and new employment opportunities in the agriculture sector.

Agriculture experts believe the move comes at

a crucial time as Pakistan faces growing challenges related to climate change, food insecurity, water shortages, and rapid population growth. They say improved seed systems and modern agricultural technologies will play a key role in ensuring sustainable food production in the future.

Officials added that the collaboration between government institutions, researchers, and the private sector would help build a more self-reliant and technologically advanced agricultural economy in Pakistan. ■

SAU Moot Calls for Harassment-Free Campuses, Stronger Anti-Harassment Mechanisms

Academicians, experts, social reformers, and civil society representatives expressed serious concern over rising violence against women, cyber blackmail, harassment, and deep-rooted structural inequalities at a national conference on Thursday, warning that weak implementation of laws and persistent social barriers continue to undermine women's safety and empowerment in Pakistan.

The National Conference on Women's Protection 2026, held under the theme "Promoting Safety, Rights and Empowerment of Women in Academia and Society," was organized by Sindh Agriculture University in collaboration with the Higher Education Commission, Sindh Higher Education Commission, Women Development Department of the Government of Sindh, and other partner organizations.

Speakers observed that women's protection is not merely a legal or social responsibility but also a moral, religious, and constitutional obligation that requires collective action from government institutions, academia, civil society, the media, and communities.

Addressing the inaugural session, SAU Vice Chancellor Engr. Prof. Dr. Altaf Ali Siyal said women constitute the backbone of society, and no nation can attain meaningful progress unless women are safe, educated, respected, and empowered. He said equal opportunities in recruitment and institutional systems must

be ensured for women, adding that women's empowerment is deeply rooted in Islamic teachings and supported by historical examples of justice and leadership.

He said that despite legislative progress, women continue to face harassment, domestic violence, workplace discrimination, cybercrime, forced marriages, and unequal access to opportunities, underscoring the need for coordinated institutional responses.

Women's activist and social reformer Marvi Awan emphasized the need for responsible handling of harassment complaints within educational institutions and cautioned against the irresponsible use of social media in such cases. She said mishandling sensitive cases not only affects

ment, Hyderabad, said barriers faced by women in society ultimately hinder broader social progress. She stressed the importance of creating a genuine sense of safety for women and girls from homes to educational institutions and workplaces, and called for an end to discriminatory attitudes toward daughters and sons within families.

Member Syndicate SAU Dr. Shabana Sartaj Tunio observed that women encounter challenges not only in institutions but also within their domestic environments, stressing the need for a broader and more comprehensive approach to women's protection.

During the event, Dr. Mahmooda Buriro presented the conference recommendations. The conference called for harassment-free campuses, stronger anti-harassment mechanisms, counselling and mental health support services, and increased scholarships for female students, particularly those from rural communities.

It also highlighted the contribution of rural women to food security and demanded equal access to land ownership, agricultural credit, irrigation facilities, modern technologies, and extension services, while recommending the establishment of women-focused agricultural support systems at district and taluka levels.

On the occasion, Dr. Feroza Soomro presented poetry, and Dr. Ghulam Hussain Wagan performed Shah Abdul Latif Bhittai's traditional Waaee. Women from diverse schools of thought, social leaders, teachers, students, and participants, including Bibi Yasmeen, Reshma Thebo, and Radha Bheel, also attended the conference. - TANDO-JAM: PR



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8th PLUGIN 2026 Showcases

Engineering Innovation at QUEST Nawabshah

The 8th PLUGIN Project and Poster Competition 2026 was successfully held at the Department of Electrical Engineering, Quaid-e-Awam University of Engineering, Science & Technology (QUEST), Nawabshah.

The event was organized by the IEEE P Local Centre Nawabshah, bringing together a vibrant gathering of students, academicians, and professionals from across the region.

Students from various universities and academic departments actively participated in multiple STEM-based categories, including Mega Projects, Mini Projects, and Technical Poster Competitions. The event served as a dynamic platform for young engineers to

nized with cash prizes, medals, and shields, celebrating excellence, innovation, and technical creativity among students.

Speaking on the occasion, Vice Chancellor Prof. Dr. Saleem Raza Samo appreciated the efforts of the organizers and participants, stating that such events are essential for promoting research culture, innovation, and practical learning among students. He emphasized that engineering education must focus on solving real-world problems and preparing students for future technological challenges.

The event was led by the Chief Organizer, Prof. Dr. Abdul Sattar Saand, who also serves as Chairman of the Department of Electrical Engineering, Chair IEEE P Local Centre Nawabshah. In his remarks, he highlighted that PLUGIN has evolved into a flagship platform for nurturing young engineers,



present innovative ideas and practical solutions addressing contemporary technological challenges.

The ceremony was graced by the Vice Chancellor of QUEST, Prof. Dr. Saleem Raza Samo, as the Chief Guest. Distinguished attendees included Prof. Dr. Kishan Chand Makwana, along with deans and senior faculty members: Prof. Abdul Fattah Chandio (Dean, Faculty of Electrical & Electronics Engineering), Prof. Abdul Sattar Jamali (Dean, Technology), Prof. Dr. Muhammad Ibrahim Channa, Prof. Dr. Muhammad Ramzan Luhur, Prof. Dr. Intasab Hussain Sadhaya, and Prof. Dr. Dadan Khan Bhangwar. Faculty members from QUEST and other universities attended the event.

Participants were evaluated by expert panels, and outstanding projects were recog-

fostering collaboration, and showcasing innovative solutions aligned with sustainable development goals. He further stated that the competition reflects QUEST's commitment to academic excellence, industry engagement, and technological advancement.

Pro Vice Chancellor Prof. Dr. Kishan Chand Makwana also praised the initiative, noting that such academic activities play a crucial role in bridging the gap between theoretical knowledge and practical implementation, and encouraging students to think critically and innovatively.

The 8th PLUGIN 2026 concluded with the distribution of awards to the winning teams, marking another milestone in promoting engineering innovation and student engagement at QUEST Nawabshah. - ERMD



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Fortnightly Engineering Review

The Future of Engineering: Integrating Sustainability, AI, and Scalability

Engr. Dr. Muhammad Nawaz Iqbal

Engineering is experiencing a new era in which the concepts of sustainability, artificial intelligence, and scalability are not only distinct goals but are becoming integral drivers of industrial progress.

Embedded intelligence will be integrated into future engineered systems to optimize energy use, minimize environmental waste, and increase operational resilience. The merging of these fields will transform the role of engineers from merely being problem-solvers to becoming creators of adaptive ecosystems capable of harnessing technology while preserving planetary resources.

Sustainable engineering combined with AI will enable environmental management on a scale never seen before. Intelligent systems equipped with machine learning algorithms will continuously track carbon emissions, resource use, and infrastructure performance in real time. Unlike traditional reactive engineering approaches, future systems will predict failures before they occur, thereby reducing material losses,

minimizing ecological disruption, and promoting more sustainable industrial systems across multiple sectors.

Scalability in future engineering will not only be linked to economic expansion but also to sustainable replication models. Engineering solutions will be designed to scale efficiently without imposing excessive environmental burdens. Renewable energy microgrids, modular housing structures, and AI-driven manufacturing systems are poised to play crucial roles in advancing sustainable development and combating climate change. This shift contrasts with traditional growth-based engineering by emphasizing regeneration-based engineering principles.

Smart cities of the future will epitomize the integration of sustainability and artificial intelligence in engineering infrastructure. Urban engineering systems

will operate within interconnected digital ecosystems in which transportation systems, energy networks, waste management systems, and public utilities autonomously communicate through AI-based platforms. These cities will feature dynamic traffic control systems, optimized electricity distribution, and real-time pollution monitoring, result-

increasingly prominent in engineering curricula. Students will no longer be taught merely to build infrastructure or machines; instead, they will learn to design smart and scalable ecosystems capable of addressing global sustainability challenges. Virtual simulations and AI-based laboratories will further customize learning experi-

ing manufacturing processes based on environmental conditions. Embedded circular economy principles will transform waste materials into reusable resources within industrial processes, creating production cycles in which products are designed for reuse and sustainability.

Biotechnology integrated with AI-based engineering will revolutionize healthcare, agriculture, and environmental management systems. Future engineering innovations may include self-repairing bioengineered materials, biodegradable electronic devices, and AI-controlled agricultural infrastructure capable of optimizing water and nutrient use. The integration of biological intelligence with computational engineering will drive the development of systems that are scalable, sustainable, and more efficient than many natural systems.

The future of infrastructure engineering will increasingly focus on adaptability through AI-enabled systems. Sensors embedded in roads, bridges, buildings, and energy networks will



monitor structural conditions, environmental changes, and potential hazards in real time. These smart structures will enable infrastructure to automatically adapt to floods, earthquakes, extreme temperatures, and rising sea levels. As a result, engineering will evolve from static construction models into living and responsive infrastructural ecosystems.

AI and blockchain technologies will also create decentralized sustainability networks within the engineering sector. Communities will increasingly rely on distributed renewable energy generation, localized manufacturing, and collaborative resource-sharing systems rather than depending solely on centralized industrial systems. Scalability will therefore become more democratic, enabling small-

Contd on page 11



ing in efficient, resilient, and environmentally friendly urban environments.

Engineering education will also undergo significant transformation through the incorporation of sustainability and AI. Interdisciplinary subjects such as environmental ethics, data science, automation, and systems thinking will become

ences and accelerate engineering innovation.

One of the most transformative developments will emerge in autonomous sustainable manufacturing systems. Future AI-powered factories will feature self-optimizing production lines that reduce material waste and energy consumption while continuously improv-

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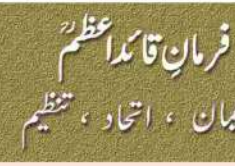
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اقبال کا ترانہ ہاگک در ہے گویا
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اے ہمالہ کوئی بازی گاہ ہے تو بھی، جسے
دست قدرت نے بنایا ہے عناصر کے لئے
ہائے کیا فرط طرب میں جھومتا جاتا ہے ابر
فیل بے زنجیر کی صورت اڑا جاتا ہے ابر

تیری عمر رفتہ کی اک آن ہے عہد کہن
واپس میں ہیں تیری کالی گھنائیں خیمہ زن
چوٹیاں تیری شریا سے ہیں سرگرم سخن
تو زمیں پر اور پہنائے فلک تیرا وطن
چشمہ دامن ترا آئینہ سیال ہے
دامن موج ہوا جس کے لئے رومال ہے
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کلونے کلونے کر رکھے ہیں۔ ہندوستان کے نقشہ پر مسلم ہندوستان
اور ہندو ہندوستان پہلے ہی سے موجود ہیں نہ معلوم اس کے متعلق
اتنا ویلا کیوں کیا جاتا ہے۔ وہ ملک ہے کہاں جس کے کلونے کلونے
کیے جائیں گے؟ اور وہ قوم کہاں ہے جس کی قومیت فنا کی جائے؟ وہ
وہ طاقت جس کے قبضہ قدرت میں آج ہندوستان ہے وہ
اگر یوں کی طاقت ہے اور یہ جو ایک خیال دماغوں میں پیچھا گیا
ہے کہ ہندوستان ایک متحدہ ملک ہے اور اس کی اپنی حکومت ہے وہ
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The Future of Engineering: Integrating Sustainability, AI, and Scalability

Contd from page 10

tional engineering will drive the development of systems that are scalable, sustainable, and more efficient than many natural systems.

The future of infrastructure engineering will increasingly focus on adaptability through AI-enabled systems. Sensors embedded in roads, bridges, buildings, and energy networks will monitor structural conditions, environmental changes, and potential hazards in real time. These smart structures will enable infrastructure to automatically adapt to floods, earthquakes, extreme temperatures, and rising sea levels. As a result, engineering will evolve from static construction models into living and responsive infrastructural ecosystems.

AI and blockchain technologies will also create decentralized sustainability networks within the engineering sector. Communities will increasingly rely on distributed renew-

able energy generation, localized manufacturing, and collaborative resource-sharing systems rather than depending solely on centralized industrial systems. Scalability will therefore become more democratic, enabling smaller and remote communities to access advanced technological solutions without excessive dependence on centralized authorities.

Autonomous mobility ecosystems will define the future of transportation engineering by combining sustainability, AI, and scalability. Intelligent navigation algorithms and electric and hydrogen-powered transportation systems will optimize traffic efficiency, reduce dependence on fossil fuels, and lower urban emissions. AI-driven autonomous logistics networks and public transportation systems will transform the global transportation landscape and contribute significantly to environmental sustainability goals.

As AI-powered sys-

tems assume greater autonomy in critical industrial and societal functions, engineering ethics will become increasingly important. Issues such as algorithmic bias, environmental justice, unequal access to technology, and responsible automation will become central concerns for future engineers. Engineering practices must therefore incorporate ethical auditing measures to ensure that scalable AI technologies enhance social welfare and equity rather than deepen economic and technological inequalities.

AI analytics and sustainable design will also characterize the future engineering landscape, with products increasingly developed through hyper-personalized approaches. Advanced engineering systems will analyze consumer behavior, environmental conditions, and product life-cycle impacts to create customized products with minimal environmental footprints. This personalization model

will reduce overproduction, maximize resource efficiency, and encourage more sustainable consumption patterns across various industries.

Sustainability and AI will play increasingly important roles in space engineering by enabling scalable space exploration and habitation. Future innovations may include self-sustaining habitats powered by renewable energy systems, AI-driven life-support technologies, and autonomous robotic construction in hostile planetary environments. Sustainable engineering concepts developed for space missions may later be applied on Earth to design resource-efficient and closed-loop technological systems.

Quantum computing may become the next major breakthrough in engineering by significantly enhancing AI's ability to solve highly complex sustainability challenges. Quantum-enhanced simulations could optimize renewable energy distribution, accelerate the dis-

covery of advanced materials, and improve the accuracy of environmental predictions. Engineering scalability will therefore extend beyond the expansion of physical systems to include the scalability of computational capabilities, enabling societies to address environmental and industrial challenges with unprecedented precision and speed.

The future of engineering represents a shift from isolated technological advancements toward interconnected intelligent ecosystems that foster innovation while maintaining sustainability. Future engineering solutions will not only be efficient and profitable but also ecologically responsible, socially resilient, and adaptively scalable. The integration of AI, sustainable practices, and intelligent growth models will position engineering as a driving force for creating a resilient, equitable, and greener civilization. ■

Millat Tractors Subsidiary Signs MoU with Chinese E-Bike Manufacturer

Millat Tractors Limited has announced that one of its subsidiary companies has signed a Memorandum of Understanding (MoU) with a leading Chinese electric bike manufacturer for the assembly, manufacturing, and marketing of electric bikes in Pakistan.

According to a notification submitted to the Pakistan Stock Exchange under the Listed Companies (Code of Corporate Governance) Regulations, 2019, the agreement marks a strategic move by the company to diversify into Pakistan's

growing electric mobility sector.

The company stated that the collaboration aligns with the Government of Pakistan's National Electric Vehicle (EV) Policy 2025-30 and reflects Millat Tractors'

group's product portfolio and strengthen its presence in the emerging electric vehicle market. Company officials said the partnership would contribute to the local assembly and manufacturing of e-bikes

while supporting Pakistan's broader transition toward cleaner and environmentally friendly transport systems.

The development is being viewed as an important step in promoting electric mobility and reducing dependence on conventional fuel-based transportation in Pakistan.

The notification was signed by Com-

pany Secretary

Mudassar Siddique, who requested the exchange to inform TRE Certificate holders accordingly. ■



commitment to supporting sustainable transportation solutions in the country.

The MoU is expected to expand the

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قابل تجدید توانائی کو فروغ، مسابقت میں رکاوٹیں دور کی جائیں، مسابقتی کمیشن
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رپورٹ میں قابل تجدید توانائی کو فروغ،
مسابقت میں رکاوٹیں دور کرنے، دو طرفہ بجلی

انفراسٹرکچر کی ترقی سندھ کی ترقیاتی حکومت عملی کام مرکز کی جزوہ مراد ملی شاہ

تعمیراتی معیار پر کسی قسم کا سمجھوتہ نہیں کیا جائے، بہتر سڑکوں کا نظام تجارت کو فروغ اور سفر کا وقت کم کرے گا
منصوبوں پر کام کی رفتار تیز کی جائے، وزیر اعلیٰ سندھ، اجلاس میں آئندہ پی ایس ڈی پی کے لیے حکمت عملی کو جتنی شکل دی گئی

زراعت، صنعت اور علاقائی روایہ کو منبھوط بنائے گا۔ اجلاس
میں پی ایس ڈی پی 27-2026 کے لیے مجوزہ منصوبوں کا بھی
جائزہ لیا گیا اور ان کی اصولی منظوری دی گئی، جن میں جیکب آباد
بانی پاس تانکدھکوٹ (100 کلومیٹر) اضافی کیرج وے ہتھکھ
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تاڈو کی بڈریا ایم مقامات (84 کلومیٹر) ڈوئل کیرج وے
شامل ہیں، وزیر اعلیٰ نے کہا کہ یہ منصوبے بالائی اور زیریں سندھ
میں روایہ کو بہتر بنائیں گے، اشیا کی ترسیل میں سہولت فراہم
کریں گے اور ساحلی تجارت میں معاشی سرگرمیوں کو فروغ دیں۔
مراد ملی شاہ نے کہا کہ انفراسٹرکچر کی ترقی سندھ کی
ترقیاتی حکمت عملی کا مرکزی جزو ہے، وزیر اعلیٰ نے منصوبوں
کی سخت نگرانی کی ہدایت دی اور محکموں کو فنڈز کے موثر
استعمال کو یقینی بنانے کا حکم دیا۔

تمام محکموں کو ہدایت دی کہ فوری طور پر کاڈوں کو دور کیا جائے،
جن میں یوٹیلیٹی انٹرنیٹ کی منتقلی، بجلی کے کھمبوں کی منتقلی اور تجاویزات
کا خاتمہ شامل ہے، انھوں نے کہا کہ انتظامی یا تکنیکی مسائل کی
وجہ سے تاخیر قابل قبول نہیں اور تمام متعلقہ محکمے باہمی رابطے کے
ذریعے منصوبوں کو مقررہ مدت میں مکمل کریں۔ انہوں نے
بالخصوص سوئی گیس پائپ لائنز، بجلی کے انفراسٹرکچر اور آبی
گزرگاہوں کی منتقلی کے عمل کو تیز کرنے کی ہدایت دی جو
منصوبوں کی تکمیل میں رکاوٹ بن رہے ہیں۔
وزیر اعلیٰ نے اس بات پر بھی زور دیا کہ تعمیراتی معیار پر کسی
قسم کا سمجھوتہ نہ کیا جائے، انھوں نے کہا کہ یہ سڑکوں کے منصوبے
معیشت کی شرک ہیں، انھیں پائیدار بنیادوں پر اور بروقت مکمل
کیا جانا چاہیے تاکہ عوام کو زیادہ سے زیادہ فائدہ پہنچ سکے، بہتر
سڑکوں کا نظام تجارت کو فروغ دے گا، سفر کا وقت کم کرے گا اور

وزیر اعلیٰ سندھ سید مراد ملی شاہ نے اجلاس کی صدارت
کرتے ہوئے وفاقی عوامی ترقیاتی پروگرام (پی ایس ڈی پی)
2025-26 کے تحت جاری بڑے منصوبوں کی پیش رفت کا
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ENGINEERING REVIEW

Science & Technology

Decarbonizing Pakistan's Textile Sector: A Roadmap for Compliance with EU CBAM

By Farhan Mujeeb

For years, the EU's Carbon Border Adjustment Mechanism sat in the comfortable middle distance for Pakistan's textile sector; an acronym in sustainability slides, a problem for the next quarter. That distance has now closed.

Since 1 January 2026, CBAM is in its definitive phase, and the embedded carbon in covered imports is a real financial liability rather than a reporting exercise. EU importers will buy and surrender certificates priced off the EU Emissions Trading System, with the first surrender due by September 2027 for goods that crossed the border in 2026. The mechanism is no longer an idea; it is a binding customs law.

The temptation, looking at the current scope, is to relax. Finished garments and fabrics are not in Annex I. Steel, aluminium, cement, fertilisers, hydrogen, and electricity are. By the EU's own count, only about 1.3 percent of Pakistan's exports to the bloc fall under CBAM today. That number is the source of false comfort. The European Commission has been blunt that the present list is the first step, not the last. Chemicals and polymers (the upstream of polyester, nylon, acrylic and elastane) are openly slated for inclusion before 2030. Textiles themselves could be pulled in around 2027. When that happens, somewhere close to 28 percent of Pakistan's EU exports begin facing carbon-related charges, and at an EU ETS price hovering near €85 a tonne, even moderate carbon intensity translates into compliance costs in the tens of millions of euros. Vietnam, Bangladesh and Türkiye will not be waiting; the exporters who arrive at the EU border with audited emissions data will keep their shelf space, and the rest will not.

What makes this a Pakistan power-sector story rather than a fibre story is that the textile industry's CBAM exposure is, fundamentally, about the electricity and steam that go into making the cloth. Three structural features of Pakistan's industrial energy landscape com-

bine to inflate the embedded emissions of every tonne of yarn or metre of fabric leaving Karachi or Port Qasim. The grid still leans heavily on imported RLNG, furnace oil, and a growing share of coal, including Thar lignite, so any mill drawing from it inherits that carbon intensity in its Scope 2 numbers regardless of how efficiently the mill itself runs. Roughly three-quarters of textile capacity has historically run on gas-based captive plants, and the 2024 IMF-aligned decision to disconnect captive gas pushed some proces-

ses equal to those emissions, less any verified carbon price already paid in the country of origin and less an adjustment for the free allowances still given to EU producers, which phase out completely between 2026 and 2034. The exporter's leverage sits in three places. First, data quality: from January 2026 onwards, an importer can only declare actual emissions if those numbers are signed off by an accredited third-party verifier, and where verified data is unavailable, Commission default values apply. Those

credible facility-level emissions baseline. Scope 1 from fuel-purchase records, Scope 2 from contracted electricity sources, and at least an initial cut at Scope 3 for cotton and synthetic fibre inputs, which EU buyers are increasingly asking for under their own due-diligence regimes. Once the baseline exists, the cheap tonnes can come out: waste-heat recovery from boilers and dryers, variable-frequency drives on motors, LED lighting, compressed-air leak management, and condensate return on steam systems routinely deliver 10 to 20 per-

cent reductions in energy intensity at payback periods under three years, and they cut energy cost per unit at the same time. Beyond efficiency lies the structural lever of decarbonising supply itself: rooftop solar still makes obvious economic sense for industrial loads with high daytime consumption even after the 2026 net-billing changes, because self-consumption economics hold regardless of what export tariffs do; behind-the-meter solar paired with storage can shift daytime generation into evening processing shifts; corporate wheeling through CTBCM, once it is genuinely operational, will let textile clusters in Faisalabad and Karachi contract directly with utility-scale wind and solar in Sindh; and biomass-fired process heat is workable where verifiable sustainable feedstocks are available.

Running through all of this in parallel is the verification trail itself: metering granular enough to allocate energy by process and product, monitoring software that retains records to ISO 14064 standards, and documented procedures a verifier can audit. The mills that begin this work in 2026 will be seen processing real verifications in 2028, and the rest will receive default values.

Mill-level effort, however determined, will only get the country part of the way. Several enabling measures rest with the state, and their



Ministry of Climate Change, NEPRA, and industry bodies such as APTMA, would bring verification costs down to something an SME can absorb. And a domestic carbon price, even a modest one applied to large exporters with proceeds recycled into industrial decarbonisation and a just transition fund, would let Pakistan keep the revenue the EU is otherwise about to collect. South Africa, India, and Türkiye are all moving on variants of this, and Pakistan's continued absence from the conversation is starting to look like a missed opportunity rather than a position.

CBAM is not really a textile policy or even a climate policy. It is an industrial policy with climate characteristics, and Pakistan's response needs to be at that level. The choice is not between adapting and resisting; the mechanism is binding EU law, and the EU is one of Pakistan's largest markets. The choice is whether Pakistan adapts on its own terms by building MRV capacity, decarbonising the grid, capturing the carbon revenue at home, and moving up the value chain into lower-carbon, higher-margin segments, or adapts on Brussels' terms, with default emission values, lost market share, and a steady erosion of the foreign-exchange base the textile sector still provides. The mills that will still be exporting profitably to Hamburg and Rotterdam in 2030 are making their investment decisions in 2026. The roadmap is not technically mysterious; the constraint is institutional, and it comes down to how quickly Pakistan's policymakers, regulators, and industry associations can settle on a shared direction and stop revising it every fiscal year. The carbon border tax is real, the window to respond on Pakistan's own terms is narrow, and it is, for now, still open.



sors onto the grid and others toward biomass, coal, or furnace oil. A fiscally driven move whose carbon outcome is mixed at best, and in some cases is moving in the wrong direction. Pakistan is also a net importer of carbon, with synthetic yarns, dyes, and chemicals from China bringing their upstream emissions along for the ride, a problem that becomes visible and expensive the moment CBAM extends to polymers.

Before drafting any roadmap, it is worth being clear about what compliance actually involves, because a fair amount of what circulates in industry circles is folklore. CBAM is a liability on the EU importer, not directly on the Pakistani exporter. The importer must register as an Authorised Declarant, report the embedded emissions of covered goods, and surrender certi-

defaults are deliberately conservative, generally reflecting the highest emissions intensity observed for that country and product, which means a mill that cannot produce verifier-ready data is effectively billed at the worst-case rate. Second, any carbon price already paid at home is deductible, and Pakistan currently has none, which means the EU is collecting the carbon revenue Pakistan is choosing not to. Third, the choice of fuels and electricity feeds directly into the calculation, so a mill running on a verified solar PPA can declare materially lower numbers than one on the grid average. The methodology rewards real action; it does not reward marketing copy.

The transition itself does not need to be heroic. It needs to be sequenced. The first step, which most mills have not yet completed, is a

cent reductions in energy intensity at payback periods under three years, and they cut energy cost per unit at the same time. Beyond efficiency lies the structural lever of decarbonising supply itself: rooftop solar still makes obvious economic sense for industrial loads with high daytime consumption even after the 2026 net-billing changes, because self-consumption economics hold regardless of what export tariffs do; behind-the-meter solar paired with storage can shift daytime generation into evening processing shifts; corporate wheeling through CTBCM, once it is genuinely operational, will let textile clusters in Faisalabad and Karachi contract directly with utility-scale wind and solar in Sindh; and biomass-fired process heat is workable where verifiable sustainable feedstocks are available.

absence will hold back even the most prepared exporter. The single biggest one is policy stability. The 2026 shift from net metering to net billing was defensible on grid-cost grounds, but it was communicated poorly and timed badly, and frequent rule changes raise the discount rate that mills apply to clean-energy investments. A ten-year visibility commitment on industrial wheeling tariffs, distributed solar export rates, and corporate PPA frameworks would unlock more private capital than any subsidy ever has. Operationalising wheeling and CTBCM beyond paper, with workable use-of-system charges and balancing arrangements, would let textile clusters source clean power directly from where it is cheapest to generate. A national MRV infrastructure, ideally built jointly by the

Solar-powered gel pulls drinking water from the air

Scientists in recent years have sought to efficiently draw moisture from ambient air and condense it into potable water using materials made of salt and absorbent polymers. But these materials, known as hydrogels, until now have degraded too quickly to be practical or cost-effective.

Researchers have now discovered a way to harvest water from air using solar power and a hydrogel that lasts for eight months or more. Attached to metal coated to prevent corrosion, the long-lasting material can produce water at low cost almost anywhere.

"There are a lot of people who don't have access to water or have to walk hundreds of hours per year to procure water," said Carlos Diaz-Marin, an assistant professor of energy science and engineering in the Stanford Doerr School of Sustainability and co-lead author of the research published May 7 in *Nature Communications*. "There are also very water-intensive industries like semiconductor manufacturing and data centers that are putting even more pressure on water systems. We believe this could potentially be a way to provide additional water resources."

"These new hydrogels are exceptionally exciting because they give us a way to produce potable drinking water in really extreme conditions," said co-lead author Chad Wilson, who worked on the hydrogel as a graduate student at the Massachusetts Institute of Technology.

In previous work, published in 2025, the team brought a hydrogel device—a square about cookie-sheet-size with a metal frame—to Chile to test it in the Atacama Desert, one of the world's driest places. They used a hydrogel made of the superabsorbent salt lithium chloride and a polymer commonly

used in diapers, polyacrylamide.

Even in the Atacama Desert's parched environment, the hydrogel filled up with water overnight. The researchers used a sheet of aluminum painted black to absorb the sun's heat and heat up the hydrogel. As it warmed during the day, the hydrogel released water as vapor, which could then be condensed back into liquid water and collected for drinking. The gel proved highly absorbent, holding between two to four times its weight in water.

While the gel was effective at attracting

people globally lack access to safe drinking water.

Building a stable sorbent

Through lab experiments over the past four years, the researchers have investigated how the hydrogel breaks down. They found that problems arise from the gel's contact with a metal surface, such as the painted foil in the Atacama Desert experiment. The metal casing is key to powering the water-harvesting process with heat from the sun, but it also releases ions that form radicals in the hydrogel and attack the polymer's long

one test, the hydrogel remained stable for more than eight months while kept at 167°F, a temperature meant to stress-test the material under extreme conditions. The researchers also found the hydrogel on coated metal remained stable for more than 190 water-harvesting cycles.

Durable hydrogels, cheap water

This level of durability advances the hydrogel toward producing water at a competitive cost. The improvements "could let us get to a point where we produce water at maybe one cent per liter," said Diaz-Marin.

This would be about 1% of the cost of bottled water and about 10 times the rate U.S. households pay for tap water. "We see a path to this technology to perhaps even being competitive with tap water."

At the right price, a future hydrogel-based water system could bring potable water to rural communities facing water shortages in arid inland regions, where other technologies such as desalination are not an option. Since it's solar-powered, it doesn't need a grid connection and would have a minimal environmental footprint compared to water that needs to be pumped or trucked in.

It's not ready to supply communities just yet, but the team is optimistic. Diaz-Marin and his students are now working to further improve efficiency and cost. Their current design can produce up to two

liters, or a little over half a gallon, of water daily with a thin layer of material spread over a panel roughly the size of a bath towel. That's around the amount of water generally needed per person per day to maintain basic health during emergencies.

Diaz-Marin said his goal is to increase the output to five liters daily. "Especially being at Stanford," he said, "I could see us translating this into the world either by a startup or licensing it." In the not-so-distant future, we could be sipping sky water. - TX



moisture even where it's scarce, the researchers soon found a problem. It lasted only about 30 cycles of filling up and releasing water before it degraded. This is a problem not only for producing water cheaply, but also for safety. "Any degradation could make either the salt or the polymer go into the condenser," said Diaz-Marin. "That would basically destroy the potability of the water."

More than half a million U.S. households lack access to running water. One in four

chains. The gel turns to goo as bits of polymer leach into the water.

"The radicals are very efficient at eating the polymer away," said Diaz-Marin. "To our knowledge, nobody had thought of durability and degradation of these materials, despite it being a critical parameter for water production."

The researchers tested interventions to block the metal ions. When they applied an anti-corrosion coating to the metal, the hydrogel's lifespan dramatically extended. In

Electricity could produce cement with almost no carbon footprint

As the world works to alter the trajectory of climate change, most attention focuses on reducing humanity's reliance on fossil fuels and lowering greenhouse gas emissions. Yet a major source of carbon dioxide (CO₂) is cement production, which accounts for 8% of global CO₂ emissions.

New low-carbon cement breakthrough

Now, researchers reporting in *ACS Energy Letters* have manufactured cement that lowers input energy demand by 70% and reduces CO₂ emissions by 98% compared with traditional production methods.

"This work defines an electrified path for cement production that could reduce the industry's massive carbon footprint by as much as 98% when using waste cement as a feedstock," said Curtis Berlinguette.

"Our team was motivated to address cement production

emissions at the source," says Berlinguette, the corresponding author of the study. "We used electricity and recycled cement to make precursors that formed a type of cement called belite at

like dams."

Why cement is so emissions-heavy

Cement is an essential ingredient for making concrete a durable construction material, because when

stone.

However, producing cement traditionally demands a great deal of energy as limestone (made of calcium carbonate, or CaCO₃) and silica-containing minerals are

nificant amounts of CO₂ as a by-product when limestone breaks down.

How the new electrochemical process works

Taking a different approach, Berlinguette and a

ical conversion of limestone and silica into a cement precursor.

The electrochemistry approach allowed the reaction to take place at 140 F (60 C). The product of this reaction was then converted into belite in a kiln at 1,200 F (650 C). The lower temperatures of this new method reduced the thermal energy required by 70% as well as cut CO₂ emissions compared to the traditional processes.

Recycling waste cement for deeper cuts

To further reduce emissions, the team tested the electrochemistry process on recycled waste cement, using it instead of limestone. This demonstration dropped emissions of the new method to 20 kilograms CO₂ per ton—a 98% reduction in emissions compared to the 800 kilograms CO₂ per ton cement released during conventional processes.

The researchers note that the electrochemical reactions produced hydrogen, which could be burned to provide the thermal energy for the second step of cement production, thus replacing fossil fuels. - TX



lower temperatures than were previously known. Belite-rich cement is important for massive structures

mixed with water, it strongly binds sand and gravel. And the starting material for cement is typically lime-

heated in two stages to more than 2,600 degrees Fahrenheit (1,450 degrees Celsius). These processes release sig-

research team at the University of British Columbia used electricity to lower the energy requirements of the chem-