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Smart Budgeting in Tough Times: Govt Sets Strategic Priorities Amid Fiscal Constraints

espite constrained fiscal space and underutilization of development funds in the current year, the federal government is charting a more focused, performancedriven development path for FY2025-26prioritizing high-impact infrastructure, economic recovery, and fiscal discipline in its Rs1 trillion Public Sector Development Programme (PSDP).

As of May 2025, only 54% of the revised Rs1.096 trillion development alloca-tion—Rs0.593 trillion—has been utilized. Yet, instead of ballooning next year's PSDP to meet Rs3 trillion in ministerial demands, the government has opted for a strategic Rs1 trillion allocation, signalling a shift towards smart development spending over symbolic outlays.

Smarter Spending, Sharper Focus
The Planning Ministry

had initially recommended

fiscal sustainability. This amount is 8% higher than last year's budget, reflecting realistic ambition without risking macroeconomic stability.

Ahsan Iqbal, Planning Minister, emphasized that a tighter PSDP would focus on

N-25 Karachi-Quetta Expressway, with Rs120 billion already earmarked

This sharper targeting ensures funds go to highreturn infrastructure likely to boost productivity, conn

lion will come from provinces. Provinces are stepping up:
Punjab is allocating

Rs1.19 trillion (+41%)

• Khyber

Pakhtunkhwa Rs440 billion (+63%) Sindh Rs887 bil-

lion (+7%)

Balochistan Rs280 hillion

This decentralized development strategy, backed by enhanced NFC transfers, reflects a more balanced federation-wide fiscal effort.

Smart Cuts, Strategic Reallocations

To realign focus, the federal government plans to cap or close 183 slow-moving projects, potentially unlock-ing Rs1 trillion in savings, including Rs100 billion for fast-track initiatives. This move avoids wastage and

lion national development outlay, of which Rs2.8 tril-



Please See Pages 9-32

A moratorium has also been imposed on small-scale projects (under Rs1 billion), and no new provincial-nature projects will be added to the federal PSDP—preventing duplication and reducing fis-

cal leakage.
Growth Targets with Guardrails The federal development



Rs1.6 trillion to expedite ongoing projects, but Prime Minister Shehbaz Sharif's fiscal team held the line at Rs1 trillion—balancing developmental urgency with

national priority projects, such as:

- Diamer Basha Dam
- Karakoram
 - Hyderabad-Sukkui

tivity, and energy security Leveraging Provincial

The Annual Plan Coordination Committee (APCC) approved a record Rs4.1 tril-

Contd on page 2 accelerates delivery







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Smart Budgeting in Tough Times:

budget aligns with a 4.2% Contd from page 1 GDP growth target and 7.5% inflation forecast. The gov-

Exports to reach

\$35 billion

Remittances to cross \$39 billion, with \$10 billion in recent gains Iqbal credited overseas

Pakistanis for countering political calls for economic disengagement, highlighting their critical role in foreign exchange stability.
Trade-Offs and Political

While strategic, the budget also bears political trade-offs Funds have been reduced for water (-45%), power (-41%), and education (-27%) sectorslargely to accommodate coalition priorities and sustain Rs50 billion in parliamentarian schemes under the SDGs Achievement Programme, which has already utilized 71% of its Rs48 billion allocation.

Iqbal acknowledged the resource crunch but insisted the Diamer Basha Dam remains a priority, despite cuts, with hopes to compress its timeline from 20 to 4 years. Infrastructure Push

Still Alive

Despite cuts elsewhere, National Highway Authority funding was increased by 27% to Rs229 billion, signaling a commitment to economic integration via road connectivity—a smart long-term bet.

Conclusion: Pragma-

tism Over Populism The FY2025-26 development strategy reflects a shift from expansive populism to selective pragma-tism. With a smaller, smarter PSDP and greater provincial ownership, the federal government aims to maximize impact per rupee. drive economic revival, and avoid project bloat.

Whether this approach leads to tangible improve-ments or gets mired in political compromise will depend on execution discipline, intergovernmental coordination, and a renewed focus on fast-moving, high-impact projects. - ERMD

Bijli Ghar





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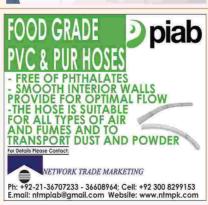
















One-Day Int'l Symposium Under EU-Funded Erasmus+ CBHE CATCH VR Projec

Digital Twins in Manufacturing Systems

funder the auspices of the EU-funded Capacity Building in Higher Education (CBHE) CATCH_VR Project, Mehran University of Engineering & Technology (MUET) hosted a one-day international Digital Twins in Manufacturing Systems Symposium.

The event convened researchers and industry experts from Ireland, Romania, Sweden, Bulgaria, Portugal, England, and Pakistan to share the latest innovations in augmented reality (VR), artificial intelligence (AI), and immersive learning.

The symposium opened with remarks by Professor Dr. Saleem Raza Samo, Vice Chancellor of QUEST, who welcomed delegates and underscored the growing importance of digital technologies in engineering education. Dr. Bhawani Shankar Chowdhry, MUET Coordinator for the CATCH_VR project, then presented an overview of the project's deliverables, tasks, and milestones.

Key presentations included:

- Dr. Pardeep Kumar Harani (QUEST) on the "Importance of Digital Transformation in Manufacturing."
- Mr. Khushi Muhammad (GIK Institute) examining "AR/VR in Modern Manufacturing."
- Prof. Dr. Agata Maolova (Technical University of Sofia) discussing "Real-Time Data Integration with Digital Twins."
 - Dr. Lehel Szaboics



Csokmail (University of Oradea) demonstrating "ON- XR: An Immersive Learning Platform and Virtual RobotDr.
Sunny Katyara

(Indusbrain Inc., UK) on "Designing Resilient and Agile Production Lines with Digital Twin Technology."

Dr. Abi
Waqas (Tyndall
National Institute,
Ireland) and Dr.
Lubna Luxmi
Dhirani (University
of Limerick) exploring technical and
security challenges
in implementing

• Mr. Dan Lejerskar, CEO of EON Reality, presenting "EON-XR Platform: Leading XR and AI Solutions for Education & Technology."

digital twins.

The day concluded with a panel discussion, moderated by

Dr. Tahir Khan (UET

Peshawar) and Dr. Ali Turab Jaffery (GIKI), which covered:

- EON Reality's 25year journey in XR and AI innovation
- Immersive learning applications in education, training, and industrial simulation
- Live AI-powered document-to-XR lesson demonstrations
- Virtual tours of robotics labs
- Global success stories and future XR and AI trends

Closing remarks were delivered by Dr. Lubna Luxmi Dhirani, Symposium Chair, who praised the collaborative spirit and emphasized the symposium's role in advancing sustainable, technology-driven engineering education. It is worth mentioning that Engineering Review is also an Associate Partner of the project. More details are available at: https://catchvr-cbhe.eu/

CASA-1000 to Deliver Clean Energy from Tajikistan to Pakistan by 2027

he First Deputy Minister for Energy and Water Resources of Tajikistan, Jamshed Shoimzoda, announced that the landmark CASA-1000 energy project between Tajikistan and Pakistan will be completed by December achieve 100% green energy and zero emissions by 2027, making efforts to implement sustainable energy projects with neighboring countries.

"The transmission capacity of the CASA-1000 project will be 1,300 megawatts, creating an energy corridor linking Tajikistan, Pakistan, and Afghanistan, delivering reliable and produce 500 billion kilowatt-minutes of electricity annually.

Highlighting the country's hydropower infrastructure, Shoimzoda said Tajikistan is home to two of the largest dams in the region: the Nurek Dam and the Rogun Dam.

The Nurek Dam, standing at 300 meters (984 feet), has a production capacity of 3,000 MW and forms Tajikistan's largest reservoir (10.5 cubic kilometers).

The Rogun Dam, still under construction, will become the world's highest dam at 335 meters (1,099 feet) and is expected to generate 3,600 MW. Once completed, it is project-

ed to double Tajikistan's energy production and play a pivotal role in achieving energy independence.

Shoimzoda noted that Tajikistan is already exporting electricity to Afghanistan and envisions becoming a regional energy hub, contributing to sustainable energy production and economic prosperity across Central and South Asia.

The CASA-1000 (Central Asia-South Asia Electricity Transmission and Trade Project) is a \$1.2 billion initiative that promotes regional energy integration among Tajikistan, Pakistan, Kyrgyzstan, and Afghanistan.



2026, and will begin supplying 1,000 MW of clean electricity to Pakistan starting January 2027.

Speaking to a news agency in Dushanbe, Shoimzoda said the project marks a significant step toward strengthening bilateral cooperation in the energy sector and represents a new era of clean and green energy for both nations.

He emphasized that Tajikistan aims to

renewable electricity," Shoimzoda explained. He added that the project will not only fulfill energy needs but also enhance regional connectivity and cooperation.

The Deputy Minister stated that Tajikistan has the capacity to export 10 billion kilowatthours of electricity annually, benefiting all regional countries, including Pakistan. He also noted that Tajikistan leads the region in hydropower generation, with the capacity to



Recycling contaminated soil from Japan's Fukushima

o reduce radiation across Japan's northern Fukushima region after the 2011 nuclear disaster, authorities scraped a layer of contaminated soil from swaths of land.

Now, as young farmers seek to bring life back to the region once known for its delicious fruit authorities are deliberating what to do with the mass of removed soilenough to fill more than 10 baseball stadiums.

Here are some key things

Why was the soil

On March 11, 2011, Japan's strongest earthquake on record triggered a huge tsunami that hit the Fukushima Dajichi nuclear plant, causing a devastating meltdown.

Topsoil was collected as part of large-scale decontam ination efforts that also included blasting buildings and roads with high-pressure jets of water.

Almost all areas of Fukushima have gradually been declared safe, but many evacuees have been reluctant to return because they remain worried about radiation, or have fully resettled els

Fukushima has, however, welcomed new residents such as 25-year-old kiwi farmer Takuya Haraguchi.

"I want people to become interested in and learn about what Fukushima is really like these days," he told AFP.

Where is the soil being

A vast quantity of soil-14 million cubic meters—is being stored at interim storage facilities near the

Fukushima Daiichi plant The government has

promised residents of Fukushima region that it will find permanent storage for the soil elsewhere in the country by 2045.



outside Fukushima to mounds are kept inside avoid further burdening guarded grounds, protected the region, where the cripby layers of clean soil and pled nuclear plant generated electricity not for local a manmade sheet to prevent runoff into the enviresidents, but for Tokyo and its surrounding urban

What will Japan do with it?

The government wants to use the soil for building road and railway embank ments among other projects

areas. So far few takers have been found in other parts of Japan, and some local officials suggest that realistically, a portion of the soil may need to stay in Fukushima.

The prime minister's office recently said it would symbolically recycle some of the soil to show it is safe. with reports saying it will be used in flower beds.

How safe is the soil? Around 75% of the stored soil has a radioactivity level equivalent to or less than one X-ray per year for people who directly stand on or work with it, according to the environment ministry

Asphalt, farm soil or layers of other materials should be used to seal in the radioactivity, said Akira Asakawa, a ministry official working on the Fukushima soil project.

In a test, the government

fields in Fukushima by using ing material.

Those locations did not show elevated levels of radioactivity, and there was no runoff of radioactive material to surrounding areas, Asakawa said.

What pushback has there

In 2022, local communities reacted angrily to plans floated by the national government to bring the Fukushima soil to a popular park in Tokyo and other areas

near the capital.

That plan has not moved forward and other locations have not yet been secured. despite public sympathy for the people of Fukushima.

The environment min istry says it will step up efforts to explain the safety of its plan to the public from this year. - ERMD

How trustworthy is A

rtificial intelligence is everywhere-writing emails, recommending movies and even driving cars-but what about the AI you don't see? Who (or what) is behind the scenes developing the algorithms that go unnoticed? And can it be trusted?

We spoke with two UC San Diego experts from the Halicioğlu Data Science Institute, part of the School of Computing, Information and Data

next for AI, including its challenges, opportunities

David Danks MA '99 Ph D '01 professor of data science, philosophy and policy, examines not just how AI systems are built, but how they shape society. Lily Weng, assistant professor, leads the Trustworthy Machine Learning Lab, which ensures AI systems are robust, reliable, explainable and orthy of our trust.

How would you define AI at its most fundamental level?

Danks: AI is any system that replaces, enhances or augments human cognitive labor. Much like machines replaced physical labor, AI assists or improves our thinking tasks. While others may focus on the technical aspects, I emphasize a human-centered view-what AI enables us to do.

Weng: You can think of it as a system that works differently from humans but is designed with the goal of assisting us. While making AI smarter or more efficient is part of the process, its purpose is to benefit humanity.

As more people are adopting AI in their daily lives, what do you find most surprising?

Danks: For me, it's people's willingness to experiment and play with these systems. People

seem very willing to spend their time and energy trying out the systems. Yet, experimentation does not often translate into continued use or trusting the system. And that's important because we probably shouldn't trust many

right now. It has surprised me that in a society where so many people act as though they are very technology-averse and don't like technology, they're nonetheless very willing to experiment and interact with AI systems, at least when the stakes are low

Where does 'responsible AI' fit in? Weng: We want AI to be responsible and trusted by users and developers. For example, you want AI to tell you what it does and how it makes a decision. Then, we can monitor or audit whether there are biases or potential concerns when it reaches the decisions. We also want AI to be robust-you don't want it to be sensitive to outside noise or an adversary that tries to manipulate it. We want AI to follow certain principles that we expect it to have

The field of AI is changing so quickly; what should we be thinking about? What are you think-

Weng: An issue that my lab has focused on is the opacity of AI. For example, the architecture of a deep-learning-based system is very complicated. So, although it has been tested and works well, there are many scenarios that can happen and many unexpected errors. My lab is working to ensure that an AI system is interpretable, and if it's not, how we can make it more explainable.

Danks: I spend a fair amount of time thinking about all of the uses of AI that aren't obvious. When I go to ChatGPT, I know I'm using AI. But when I drive my car-which these days is like a computer on wheels-I don't know how much AI has been put in there by the car manufacturer. I don't know to what extent they are using AI to control the engine or for surveillance purpose perhaps they are selling my data to an insurance company.
So, while it's great when AI can happen

behind the scenes and make everything better, it also raises opportunities for additional risks where we will not have the appropriate recourse, particu

larly if we don't even know that a harm has occurred. We need transparency about whether Al is being used, and we need transparency about what the AI is doing when it's being used.

How will the newest school at UC San Diego, SCIDS, address some of the issues and question you have presented?

Danks: I think the school creates enormous opportunities for us as researchers and educators because it starts to break down the silos between the fundamental and experimental research that occurs at the Halicioğlu Data Science Institute and the enterprise-grade commercial-level software deployments that are possible through the San Diego Supercomputer Center.

I think the school as the opportunity to ee research go all the vay from the lab to ommercial and socie tal impact. And this creates not only oppor unities, but also new obligations for us to do this responsibly and ethically and to show that responsible AI is not an oxymoron.

What is something that AI could never replace? Danks: Any job tasks that require some sort of emotional or empathetic connection with another human being will be very hard. Al systems can simulate an empathetic connection, but building that long-term connection is something the syst will struggle with a lot.

Another area where AI systems will continue to struggle is dealing with situations where it's not entirely clear what success means. These systems are built to ontimize solutions to problems where we know what suc cess is, but there are times when we don't know what actually counts as success, and we figure it out by muddling through our lives.

What is exciting for you about the future of AI? Weng: I'm very excited about the potential of AI in health care. For instance, how can we provide a higher quality of health care with the assistance of Al? But a major bottleneck is trustworthiness, as health care applications carry significantly higher risks and require stringent safety measures. They have a much higher standard than, say, a chatbot or the

That's why a trustworthy diagnosis becomes very important, especially when it comes to interpretability-we need to ensure the AI-driven decisions are transparent and reliable. I'm excited about the research in my lab and the work of my HDSI colleagues as we strive to develop AI systems that peo Any final thoughts on AI for our readers?

Danks: There is sometimes a temptation to think of AI as a hurricane that's just bearing down on us: It's going to transform our lives maybe even wreck our lives, and there's nothing we can do about it. But I think that's the wrong way to think about technology because Al is built by us. Al is a future that we are building right now. We should view it as an opportunity rather than something we have no idea whether we will make it through. -- TP/ERMD



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The Use of Neural Networks and Related Algorithms for Predictions: An Engineering Perspective

By Syed Umair Ali

In modern engineering, the ability to analyze data and make accurate predictions has become essential, whether in designing efficient systems, managing industrial processes or optimizing resources. Neural networks and their associated algorithms have emerged as powerful tools in this context, enabling engineers to solve complex prediction problems with high precision. This article explores how neural networks work, how they are trained, and their practical applications in various engineering fields.

What Are Neural Networks?

A neural network is a computational model inspired by the structure of the human brain. It consists of interconnected processing units called neurons, arranged in layers:

- Input Layer: Receives raw data (e.g., sensor readings, time-series values).
- Hidden Layers: Perform intermediate computations using weighted connections and activation functions.
- Output Layer: Produces the final prediction or classification result.

Each connection carries a weight, and each neuron applies a non-linear activation function (e.g., ReLU, sigmoid) to introduce complexity into the model's behavior. This architecture allows neural networks to approximate complex functions and relationships between input and output variables.
Predictive Modeling in Engineering

Neural networks are particularly valuable in engineering for solving tasks that involve:

- System Identification and Control: Modeling nonlinear systems where traditional equations are hard to derive.
- Fault Detection and Diagnosis: Predicting failures in industrial equipment using sensor data.
- Load Forecasting: Estimating future power or network loads.
- Predictive Maintenance: Forecasting equipment health using vibration, temperature, or acoustic signals.
- Quality Control: Classifying product quality using image or signal analysis.

Key Algorithms That Power Neural Networks

1. Backpropagation

This is the core algorithm for training neural networks. It uses the chain rule of calculus to compute the gradient of the loss function concerning each weight. This gradient is then used to update the weights in a

direction that minimizes error. 2. Optimization Algorithms

These algorithms determine how weights

cy on specific paths. 4. Activation Functions Introduce non-linearity to the model:

NEURAL NET AND RELATED ALGORITHMS FOR PREDICTIONS

- are updated during training:

 Gradient Descent: The most basic form, updating weights incrementally based on the gradient.
- Adam (Adaptive Moment Estimation): Combines momentum and adaptive learning rates, leading to faster convergence and better performance in noisy datasets.
 - 3. Regularization Techniques To avoid overfitting and improve generalization

ReLU (Rectified Linear Unit): Common in deep networks due to computational efficiency.

Sigmoid/Tanh: Used in binary or bounded output cases.

Common Neural Network Architectures

in Engineering

Case Example: Predictive Maintenance in Manufacturing

Imagine a manufacturing plant where

To avoid overming and improve generalization. Imagine a manufacturing plant where				
Architecture	Description	Use Case in Engineering		
Feedforward Neural Networks	Basic architecture for regression/classification	Predicting system outputs based on inputs		
Convolutional Neural Networks (CNNs)	Designed for spatial data	Defect detection in manufacturing via images		
Recurrent Neural Networks (RNNs) / LSTMs	Handle time-series data	Load forecasting, anomaly detection		
Autoencoders	Learn compressed	Signal denoising, fault		

- L2 Regularization (Ridge): Penalizes large weights.
- Dropout: Randomly deactivates neurons during training to prevent dependen-

motor vibrations are continuously monitored. A neural network can be trained using past vibration data to detect patterns that precede failures. Using an LSTM model, engin

can predict the Remaining Use ful Life (RUL) and schedule maintenance before failure occurs, saving downtime and costs. Implemen

tation Tools Engineers can implement neural networks using libraries such as:

- TensorFlow / Keras (Python)
- PyTorch
- MATLAB's Neural Network Tool-

These platforms offer pre-built layers, training utilities, and GPU support to simplify deployment.

Challenges in Engineering Contexts

- Data Collection and Preprocessing: Sensor data often requires filtering, normalization, and alignment.
- Model Interpretability: Engineers may need explainable predictions, which is a challenge with deep models.
- Real-Time Constraints: Some applications (e.g., control systems) require fast inference and lightweight models. Conclusion

Neural networks, supported by sophisticated algorithms, offer engineers a robust framework for predictive modeling. Whether enhancing safety, improving product quality, or reducing operational costs, these AI tools are reshaping engineering practices. As data-driven engineering continues to evolve, neural networks will play an increasingly vital role in intelligent system design and optimization.

About the Author:

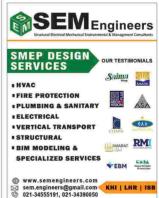
The author is a passionate writer and blogger, and the founder of https://thepengenius.com, a platform dedicated to exploring ideas that inspire growth, creativity, and meaningful living. With a keen interest in personal knowledge management, emerging trends in Artificial Intelligence, and innovative strategies for leading a more fulfilling life, Umair blends curiosity with purpose in his writing. His work reflects a continuous pursuit of insight, offering readers fresh perspectives and practical tools to thrive in an ever-evolving world.

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Engineering Review















Entrepreneurial Thinking in Engineering Education

Engr. Dr. Muhammad Nawaz Iqbal

hanging the primary perspective of engineering students is the foundational step in promoting entrepreneurship in engineering education

Beyond acquiring skills, students should learn to approach problems as innovators-spotting gaps and imagining possible solutions. As a result, they begin focusing on formulating meaningful problems worth solving, which is a core aspect of entrepreneurship

To cultivate this mindset, curriculum developmen should incorporate realworld, ambiguous situations. Educators should draw from industry, societal, and technological challenges to design problems with no single correct solution. This approach trains students to embrace uncertainty and apply inventive problemsolving as they work toward solutions

Project-based learning is particularly effective in fostering entrepreneurial skills. When students are given multidisciplinary projects, they must collaborate, generate ideas, and iterate on improvements. This enables them to understand the delicate balance engineers must strike between functional

requirements, client needs, costs, and market constraints

Using case studies in entrepreneurship courses helps bridge the gap between theoretical knowledge and its practical application. Exploring the successes and failures of engineer-led startups helps students learn about scalabili-

venture creation. This gives engineering students a broad er perspective on innovation and boosts their confidence in launching or co-launching ventures.

must also evolve to support entrepreneurial education. Traditional exams test memo lenges of entrepreneurship.

Universities should provide facilities that foster entrepreneurship within engineering departments. Innova tion centers, maker labs, and prototype workshops enable students to bring their ideas to life—regardless of financial background. CompetiIncorporating sustainabil-ity and ethics into entrepreneurial education ensures that innovation generates both profit and positive impact. When students are trained to evaluate the environmental, social, and ethical implications of their ideas, they are more likely to pursue lasting and responsible ventures

Storytelling is a vital skill for communicating complex engineering ideas to nontechnical audiences. Storytelling training helps engineers craft compelling narratives, which are essential for pitching ideas, attracting users, and inspiring teams.

Artificial intelligence and data analytics are increasingly important in entrepreneurial education. Engineer-entrepreneurs who understand how to leverage data can make smarter design decisions, better understand user behavior, and identify trends that drive disruptive innovation

Failure is a vital learning experience in entrepreneur ship. Students should be encouraged to experiment without fear of poor academic consequences. Reframing failure as a step in iteration builds resilience, adaptability, and a positive mindset-core traits of successful entrepreneurs

Involving successful alumni helps sustain student interest in entrepreneurship.



Alumni can participate in guest lectures, mentorship, and workshops, sharing practical insights grounded in their own engineering and entrepreneurial experiences.

Finally, universities must institutionalize entrepreneur ial thinking by adapting policies to support innovation. This includes offering flexible credit options for entrepreneurship, providing assistance with intellectual property, and supporting startup incubation. Innovation should be valued on par with academic excellence.

The ultimate goal of fostering entrepreneurial thinking in engineering education is to cultivate a culture of curiosity, risk-taking, and value creation. This prepares engineers not just to build products, but to lead innovation and shape the future.



ty, pivoting, and value proposition design. This method also allows students to relate more closely to entrepreneurial thinking and see it as grounded in real-world expe

Facilitating collaborative efforts between engineers and business professionals is another effective method of promoting entrepreneurial thinking. Courses jointly offered by engineering and business departments, as well as shared labs and startup incubators, can expose students to business models, customer engagement, and

ry, but not creativity, decision-making, or risk-taking. Educators should incorporate pitch presentations, startup simulations, and reflective journals to help students think and express themselves like entrepreneurs.

Having a mentor signifi-cantly enhances students' entrepreneurial abilities. Direct interaction with startup founders, industry disruptors, and engineering entrepreneurs provides invaluable insights and encouragement. These relationships help students clarify their own goals and understand the real chal-

tions such as hackathons, idea sprints, and pitch contests simulate real business dynamics and encourage fast thinking, interdisciplinary collaboration, and public communication.

Cross-cultural exposure also enhances entrepreneurial perspective. International exchange programs, global innovation competitions, and virtual collaborative projects expose students to diverse markets and user needs. This global involvement enables them to develop adaptable, empathetic, and context-sensitive solutions.

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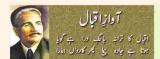
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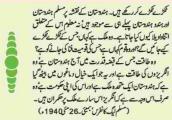
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اے مالہ کوئی بازی گاہ ہے تو بھی جے وست قدرت نے بنایا ہے عناصر کے لئے ائے کیا فرط طرب میں جھومتا جاتا ہے ابر یں ہے زنچر کی صورت اڑا جاتا ہے ابر تیری عمر رفتہ کی اک آن ہے عبد کہن وادیول میں ہیں تیری کالی گھٹا کین خیمہ زن چیاں تیری ثریا ہے ہیں سرگرم سخن تو زمیں پر اور پہنائے فلک تیرا وطن چشمہ دامن ترا آئینہ سال ہے دامن موج ہوا جس کے لئے رومال ہے اہر کے ہاتھوں میں رہوار ہوا کے واسطے تازیانہ دے دیا برق سر کوسار نے





اصول اورتفصيلات

گاندهی جی کہتے ہیں: "ہندوستان کوجیتے جی کار کے کار

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Riazul Hasan (Marhoom)

Muhammad Salahuddin

Manzoor Shaikh

Prof. B. S. Chaudhry Engr. Farhat Adil Engr. Khalid Pervaiz Engr. Sohail P. Ahmed Dr. Moh. Nawaz Iqbal

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Empowering Women Entrepreneurs

PSW Expands Training to Boost International Trade Participation

he Pakistan Single Window (PSW). under its flagship Khadijah Women Entrepreneurship Programme, successfully conducted its fifth onsite training event in Multan, aimed at strengthening the role of women entrepreneurs in international trade.

The event was organised in collaboration with Strive Women, a global initiative led by CARE and supported by the Mastercard Center for Inclusive Growth.

This capacity-building workshop provided critical training in cross-border trade procedures, e-commerce, digital marketing, customs processes, and financial access. These skills are essential for enabling women-led businesses to enter and thrive in international markets, aligning with Pakistan's trade facilitation objectives and the Sustainable Development

Goals (SDGs) 2030. PSW CEO Aftab Haider highlighted the programme's

"The Khadijah Women

Entrepreneurship Programme is

Director Adil Sheraz praised the collaborative effort:

"Our partnership with PSW served regions like Multan receive the support they need to

delivered the keynote address: "The Khadijah programme provides a unique opportunity for women in South Punjab to engage with global markets. We must continue supporting such

initiatives."

Also in attendance was Qurrat Ul Ain, Vice President of the Federation of Pakistan Chambers of Commerce and Industry (FPCCI), who emphasised the

broader economic implications: "For sustainable national growth, it is critical to ensure equitable access for women entrepreneurs. Initiatives like Khadijah are instrumental in achieving this."

The event reaffirmed PSW's commitment to digitising trade processes and promoting gender-inclusive economic growth. The Khadijah Programme continues to serve as a vital platform for empowering women across Pakistan by connecting them with opportunities in the global marketplace. - ERMD/APP



economic inclusion. By removing systemic barriers, we empower women to participate actively in global trade."

CARE Pakistan Country

grow their businesses and contribute to a resilient economy.

Farah Saqib, President of the Women Chamber of Commerce and Industry, Multan, served as the Chief Guest and

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For the performance of Hajj and its sacred rituals

Pilgrims from all over gather as individuals

All in white apparel, dressed identical - From Mecca to Mina, together they travel

They shun worldly pleasures, and do not quarrel - Piety is their best capital

The main event begins after the morning's ritual - In the plains of Arafat, each would assemble

Hands raised in prayer, tears visible - They repent, hearts soft and humble

Muzdalfa is next; as the night envelops Combining Maghreb and Isha, a deed

They pray through the night, sleep only a little - And gather the pebbles for the stoning ritual

After morning prayers, to Jamarat they hustle - For stoning the pillar, the devil's symbol

Then they sacrifice an animal, as is traditional — A goat, sheep, cow, or a camel—each permissible

This is followed by clipping the hair, an act admissible

- Shaving the head, however, is more preferable

Ihram is replaced with clothes more usual - For Tawaf e Ziarah, towards Mecca they travel

Then between Safa and Marwah, they shuttle - Honoring a desperate mother in deep trouble

They stay in Mina, two days-three, if desirable - And stone the Satan, most despicable

The farewell Tawaf is the last of the ritual - Like the newly born, they return from the holy festival







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خطے کی بڑی اور جدید کلائمنٹ آبزرویٹری کے قیام کی منظوری

خطے کی بڑی اور جدید کلائمنٹ آبزرویٹری کے قیام کی منظوری موسمیاتی تبدیلیوں معلق بروقت معلومات کے لیے جدید سائنسی مركز قائم ہوگا

اجلاس میں یو نیورٹی آف انجینئر نگ

كوبتايا كباكه كلائمنث آبزرويثري پنجاب يلانگ اينڈ ڈويليمنٹ باؤس میں قائم کی جائے گی جیکهاس کامرکزی وْھانچەاى آئى سى ئى مى تغير كياجائ كاءاس

ميں جديدخود کار کمیونیکیشن اورائج سشم نصب ہوگا جبکہ جی آئیالیں لیب ہیکورل انٹرفیس سٹم اورجدید وْيِنَامِبِ بِهِي قَامُم كِيهِ جِائِينِ كِي انظرن شپ يروكرام كابحى آغاز كياجائے گا۔

وز مراعلیٰ پنجاب مریم نوازشریف نے منظوری دی گئی۔ خطے کی سب سے بردی اور جدیدترین کلائمنٹ آبزرویٹری کے قیام کی باضابط منظوری دے اینڈ شیکنالوجی، بدای ٹی لا ہورکی جانب سے دى،اسلط مين ايك جديد سائنسي مركز بهي بيش كي گن د پورث كاجائزه بهي ليا كيا، اجلاس

قائم کیاجائے گا

تاكهموسمياتي

تبديليون

متعلق هرونت

معلومات حا

بلانس تغير كررب بين، نيوكيئر توانا كي صرف

اعلى سطح كااجلاس سينتروز برينجاب مريم اور نگزیب کی زیرصدارت منعقد ہواجس میں آبزرویٹری کے قیام، بجث،آلات اور زمین کی فراہی ہے متعلق فزیملٹی ملان کی

تیزی سے جاری

یا کشان ستی و ماحول دوست جو ہری تو انائی پیدا کر نیوالے 20 بڑے ملکوں میں شامل پيداواري صلاحيت 8000 ميگاواٿ تک بڙها نامدف، جنرل منجر چشمه نيوکليئر کمپليس

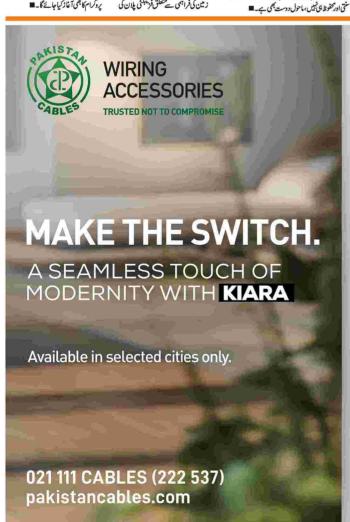
پيداوارى صلاحيت 3530ميگاواك ب، چشم 5 پراجيك كى چشم 5 پراجيك جديد باؤلونگ ون ويرائن پرفى ب، يقرو چشمہ 5 نیوکلیئر یاور پلانٹ پر کام تیزی سے جاری ہے،

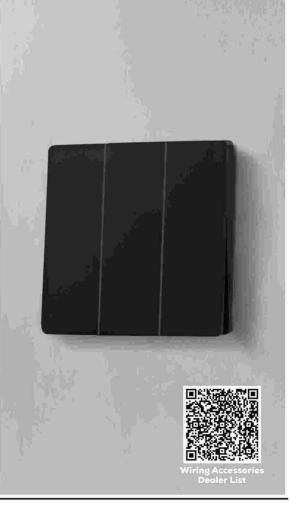
جزیش بریشرائز ڈواٹرری الیکٹرہے۔اس يراجيك كويا كتان انامك انرجي كميشن اور پائن بیشن نیوکیئر کار پوریش کے تعاون سے علی کا بیشن کیا جارہا ہے۔ ممل کیا جارہا ہے۔ انھوں نے کہا کہ نیوکلیئر توانائی دوبارہ ہے عالمی توجه حاصل کردہی ہے۔ امریکہ جایان، برطانيه جنولي كورياسميت متعدور في يافتة ممالک جوکہ نیوکلیئراقوانائی بتدرت ترک رہے تنے، پھرےاں پرفوس اور نے نیوکلیئر

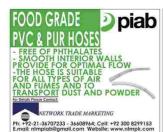
محیل براس سے 1200 میگاواٹ سنتی اور ماحول بیکی پیشنل گر فیرمیں شامل ہوگی۔ جزل منجر چشمه نیوکلیئر پاور کمپلیکس انجینئر حبیب الرحمٰن نے دوران بریفنگ صحافیوں کو بتایا کہ یا کتان کابدف جو ہری توانائی کی پیداواری صلاحيت 8000 ميگاواث تك بردها نااور ملك ميسستى اوريائيدارتواناكى كي حصول كا ایک قابل اعتاد ذر بعد بنانا ہے۔

انھوں نے کہا کہ پاکستان نیوکلیئرتوانائی يداكر نيوالے 20 برے ملكوں ميں شامل ہے . ، ملک میں اس وقت چھآ پریشنل نیوکلیئرری ایکٹرز ہیں جن کی

محیل سے 4730 میگاواٹ ہوجائیگی۔انھوں نے بتایا کہ

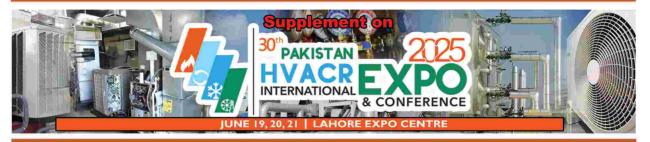












Pakistan HVACR Expo 2025: Ushering a New Era of Sustainable Innovation

30th International HVACR Expo & Conference returns with global participation, youth engagement, and focus on energy-efficient, eco-friendly technologies.

he 30th Pakistan HVACR International Expo & Conference 2025, set to take place from June 19–21 at the Lahore Expo Centre, marks a significant milestone in the evolution of HVACR innovation in the region.

Organized under the theme "Sustainable the event brings together the expanding domains of Heating, Ventilation, Air Conditioning & Refrigeration (HVACR), Mechanical, Electrical & Plumbing (MEP), and Building Materials Services, creating a cohesive platform for technological advancement, sustainable design, and economic collaboration.





With over 33 international companies from countries such as Germany (joining for the first time), China, Turkey, Ukraine, and Iran, this year's exhibition reinforces Pakistan's growing importance in the global HVACR ecosystem. Over 250 exhibitors and thousands of professionals are expected to attend the largest dedicated HVACR trade event in Pakistan, offering a dynamic mix of networking, knowledge exchange, and cutting-edge product demonstrations.

ting-edge product demonstrations.
What's New at the 2025 Expo?
Focus on Energy Efficiency & Green

Post-COVID, the HVACR industry has undergone a paradigm shift. With rising con-

Contd on page 11



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designed to control condensation and energy losses in cooling and heating systems.



It is suitable for such applications like duct and pipe insulation for air conditioning, cold wate chilled water, but water and refrigeration as well as within CEM applications. Designed for indoor aird outdoor applications, however outdoor applications need additional protection gainet weather conditions and LIV refusation.

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diffusion resistance factor and low thermal conductivity. It is suitable for such application like duct and pipe insulation for air conditioning, cold water, chilled water, hot water and refrigeration.

Designed for indoor and cutdoor moderations between nutdoor specification needs withflows.

Designed for indoor and outdoor applications, however outdoor application needs addition protection against weather conditions and UV radiation.







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DDSU666/DT(S)SU666 Smart Electricity Meter



PA/PZ/PD666 Three Phase Digital Multi-function Meter

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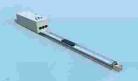
Fast DC Charger Rating 150/180kW Dual Plug

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Empowering Pakistan's HVAC Industry with World-Class Brands

SK International. based in Karachi, is a prominent distributor of heating, refrigeration, and air conditioning (HVAC) equipment in Pakistan.

Established in 2010, the company

has built a strong reputation for supplying high-quality products and maintaining excellent customer service.

MSK International has established itself as a leading distributor in Pakistan's HVAC sector By partnering with renowned international brands, the company ensures the availability of superior quality products to meet the diverse needs of its clients. Its extensive inventory and commitment to customer satisfaction have contributed to its strong market presence.

They are partnered with numerous worldrenowned brands such as Errecom SPA, Mueller, ALCO, Honey-

well, Suniso, Danfoss, Saginomiya Castel, Superlon, Fuji, Packless, Robinair, Imperial, P&M, and Bristol Compressors. Our extensive reach serves the construction industry, OEMs, end users,

contractors, dealers, and distributors across Pakistan

Errecom SPA is a leading Italian npany specializing in the formulation and production of chemical solutions for air conditioning and refrigeration systems. Established in 2001 and head quartered in Italy, the company has become a significant player in the

COM COLUTIONS

> HVAC/R (Heating, Ventilation, Air Conditioning, and Refrigeration) industry over the past two decades.

Errecom has expanded its reach beyond Italy, establishing branches in

the United States in 2018 and the Middle East in 2021. Its products are now exported to over 130 countries, serving oth the automotive and HVAC sectors The company's commitment to quality and innovation has made it a trusted partner for Original Equipment Manu facturers (OEMs) worldwide.

Errecom SPA specializes in chemi-cal solutions for air conditioning and refrigeration systems, including refrigeration lubricants They provide specialized lubricants and disinfectants tailored for various applications.

At the core of Errecom's operations is its in-house chemical laboratory, which focus-es on developing timely and innovative solutions to address challenges in AC/R systems. The company's commitment to sustainability is evident in its use of biodegradable raw mate rials, eco-friendly packaging, and products designed to optimize system performance while reducing environ-

mental impact. This dedication to green practices has earned Errecom recognition as one of the 100 most sustainable Italian companies by Forbes.

Pakistan HVACR Expo 2025: Ushering a New Era of **Sustainable Innovation**

Contd from page 9

cerns over health, indoor air quality, and climate impact, this year's expo is centered on sustainable technologies and energy-efficient solutions-critical for a country like Pakistan facing chronic energy shortages. From eco-smart cooling systems to low-carbon refrigeration technologies, the event puts the spotlight on climate-conscious engineering.

Unprecedented Academia & Startup Participation

For the first time in the expo's history, the platform is opening its doors young innovators. Over 21 universities from across the country will showcase student-led startups, offering a glimpse into the next generation of engineers shaping the industry's future. These academic exhibits, supported by signed MoUs between the Society and engineering institutions, aim to bridge industry-academia collaboration and promote homegrown innovation.

Empowering SMEs The Expo offers a pow

erful platform for Small and Medium Enterprises (SMEs) to introduce new machinery, materials, and solutions. It provides local manufacturers a front-row seat to observe

global innovations, adapt them, and scale for domestic and export markets. This focus on local capacitybuilding is a step toward import substitution and export-driven growth.

International Training and Technical Knowledge

Global expertise takes center stage with technical sessions and workshops led by industry experts from the U.S., Egypt, and Malaysia. Engineers and professionals can attend hands-on training programs and presentations of technical papers, offering invaluable exposure to emerging standards and prac-

Free Accommodation for International Visitors

In a move to boost international participation and forge cross-border partnerships, free accommodations are being offered to foreign visitors, allowing seamless access to Pakistan's growing HVACR market and opportunities

A Message from the

Leadership Ramzan Sharif, President of the Pakistan HVACR Society, emphasized that this landmark 30th edition stands not only as a celebration of industry growth but as a

Contd on page 21





& Refrigeration Chemica

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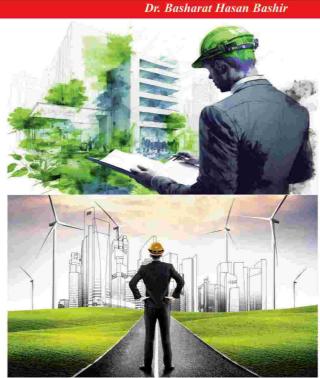


Climate Change & Environment

Why Engineers Must Be Appointed to **Engineering Positions Under the PEC Act**

ngineering is more than just ✓ drawing plans and doing math. It's about building the future, protecting lives, and sustaining our plan-

That's why the Pakistan Engineering Council (PEC) Act makes appointing only registered engineers to engineering roles mandatory.Legal Compliance is MandatoryThe PEC Act of 1976 clearly states that only PEC-registered engineers can be appointed to engi-neering roles in both the public and private sectors. This includes think tanks, NGOs, INGOs, and international organizations working in Pakistan. Violating this is not just unethical it's illegal. The Supreme Court has given several rulings in this regard. Technical Expertise Can't Be ReplacedEngineering decisions — whether it's about infrastructure, water supply waste management, climate change, or energy direct consequences on



sustainability Appointing nonengineers leads to flawed designs, poor implementation, and even disasters.Climate Change Needs Environmental EngineersAs climate threats grow, the role of environmental engineers becomes even more critical in climate change mitigation and adaptation. They

AccountabilityPEC-regis-tered engineers must follow

a professional code of con-duct. If they fail, they are

held accountable. Can you

of Appointing Non-Engi-

neersDesign failuresUnsafe

say the same for unqualified appointees?Consequences

fundsNo one to hold accountableIs that really a risk we want to take?Imme diate Action RequiredWe must not let connections, influence, or administrative shortcuts override merit and expertise. If we are serious about safety, sustainability, and national development. then qualified engineers and especially environmen-tal engineers — must be appointed to engineering positions under the PEC Act (Taken from the author's LinkedIn account)







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Top 21 HVAC Industry Trends and **Innovations to Watch in 2025**

that nearly 50% of the world's final energy consumption is used for heating and cooling? Yup, that's right.

HVAC (an acronym for Heating, Ventilation and Air Conditioning) is the largest energy end-use sector, out-pacing both electricity generation and transportation. It's also responsible for over 40% of global energy-related carbon dioxide emissions This massive consumption is straining power grids and consumer wallets. Most alarming of all is that it's also nudging Mother Earth toward an unsettlingly uncertain future, underscoring the urgent need for energy efficiency and innovative tech-

In this blog, we'll explore the key trends and innova-tions set to shape the HVAC

business landscape this year, including advancements in high-efficiency systems, smart energy managemen

Industry in 2025 Increased Demand for Energy-Efficient Systems Increased energy con

market size alone is estimated to grow by over \$21 billion by 2028. Leading this charge are innovations such

Advanced heat exchangers are leading this charge These technologies,

mental footprint. A much needed win-win!

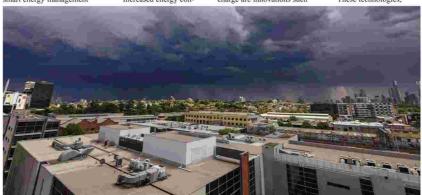
Adoption of Eco-Friendly Refrigerants

Whether it's in homes, malls or office buildings, traditional refrigeration systems have long used refrigerants like R-22, which have a high Global Warming Potential (GWP). But what is GWP exactly? It's a measure of how much heat a greenhouse gas traps in the atmosphere compared to carbon dioxide

Did you know that R-22 has a 100-year GWP of 1,810 - making it nearly 2,000 times more potent than carbon dioxide?

Just one pound of R-22 has the same impact on glob-al warming as emitting a ton of CO2. To put it into perspective, releasing a single 30-pound tank of R-22 is more damaging than the CO2 emissions from driving nearly seven cars for an entire

Contd on page 14



and global initiatives aimed at doubling energy efficiency

1. Energy Efficiency and Sustainability in HVAC

sumption, escalating temperatures, spiked utility bills the call for sustainability has never been louder. In fact, the HVAC energy efficiency

Variable speed compres-

High SEER (Seasonal Energy Efficiency Ratio) rat-

fixed and

Multiple

display pages to show
Definition of threshold values for the alarm relay, definition of hysteresis

FA 500 - Dew point sensor with integrated display and alarm relay

♦ Scaling of the analog output 04...20 mA and switching to other measured variables

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Jubilee Corporation: A Legacy of **Excellence in Pakistan's Electrical Industry**

or over six decades, Jubilee Corporation (JC) has stood as a symbol of innovation, reliability, and engineering excellence in Pakistan's electrical industry.

Established in 1962, JC has evolved from a pioneering private engineering organization to a nationwide leader in the provision of high-quality, cost-effective, and technologically advanced electrical solutions. Its unwavering dedication to excellence and customer satisfaction has earned JC the trust of consultants, contractors, manufacturers, and industrial clients across the country.

A Comprehensive Range of Engineering Solu-

Jubilee Corporation offers a diverse portfolio of products and services that cater to a broad spectrum of sectors-industrial, commercial, and residential. These include:

- Low Voltage & Medium Voltage Switchgear: Ensuring safe and efficient power dis-tribution, these solutions are designed with advanced safety mechanisms and high operational reliability.
- Power Distribution Systems: Engineered to streamline and optimize electrical infrastructure, enhancing performance and energy efficiency.
- Automation Solutions: Supporting the future of industrial automation, JC's offerings help industries boost productivity and streamline opera tions
- Energy Management: Designed to help businesses monitor and optimize their energy con-sumption, contributing to sustainability and operational cost-effectiveness.
- Power Quality Solutions: Addressing voltage fluctuations, harmonics, and other disturbances, these products ensure a steady, clean

power supply for sensitive applications

Motion Division: Enhancing operational efficiency with our Motion Division portfolio, featuring advanced drive and motor solutions tailored for diverse industrial applications.

External Lightning Protection & Earthing Systems: Protecting life and infrastructure with robust systems that guard against lightning strikes and electrical surges

One of Jubilee Corporation's defining strengths is its partnership with over 35 globally recognized manufacturers, making it an authorized distributor of premium international brands. These strategic alliances empower JC to provide cutting edge technologies and world-class products, tailored to meet the evolving needs of the Pakistani market. Through these collaborations, JC ensures that its clients remain aligned with global



mentation and Controls: Delivering accurate moni toring and regulation of processes, crucial for modern industrial automation

Pneumatic Systems: Providing precision in motion control for a wide range of manufacturing applications

This broad offering makes JC a one-stop destination for businesses seeking complete electrical and automation solutions

Strategic Partnerships with Global Industry

advancements in electrical, electronic, and

Nationwide Presence and Distribution Network

To ensure accessibility and efficient service delivery, JC has established a strong national footprint. Its Head Office is located in Karachi, with a regional office in Lahore and liaison offices in Islamabad, Faisalabad, Multan, and Peshawar, This geographic presence is backed by a nationwide dealer and distribution network, ensuring that JC's

products and services are readily available throughout the country

Customer-Centric Approach and Technical

At Jubilee Corporation, the customer is at the core of every decision. JC is not just a product supplier—it is a solutions partner. From the first consultation to long after the sale is made, JC remains actively involved in supporting its clients.

What truly sets JC apart is its unparalleled technical and after-sales support. The company boasts a team of highly skilled and experienced engineers who offer expert guidance, troubleshoot technical challenges, and ensure smooth integration of products into client systems. This level of personalized service strengthens customer relationships and builds trust in JC's capabilities.

Whether a customer needs assistance selecting the most appropriate equipment or guidance in implementing safety measures, JC's expert support team is always ready to help.

Staying Ahead in a Dynamic Industry The electrical industry is constantly evolving, with new challenges and innovations emerging every day. Jubilee Corporation has proven its ability to adapt and lead by staying informed about global trends and aligning its offerings with the latest technologies. This proactive approach has helped JC maintain its position at the forefront of the industry for more than 60 years.

Looking ahead, JC remains committed to continuous innovation, expanding its network, and delivering excellence in every aspect of its operations. Its legacy is built on trust, expertise, and a deep understanding of market needs—values that

will continue to guide its future endeavors.

For further details and queries, reach out to Jubilee Corporation at jubilee.corp@jubileecorpo ration.com or UAN: +92 21 111 000 520 or visit our website at www.jubileecorporation.com.■











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Top 21 HVAC Industry Trends and

Innovations to Watch in 2025

Contd from page 13

That's why the shift toward refrigerants with lower GWP to comply with environmental regulations couldn't have come at a better time. Harmful refrigerants like R-22 are being phased out in favor of eco-friendly alternatives such as R-32 and R-1234yf. These new refrigerants not only comply with international environmental agreements but also boost system efficiency. Embracing these alternatives is a significant step toward combating climate change - and it's about

perature right from your smartphone, even

when you're miles away.

These devices pick up on your habits and automatically adjust settings so you always come home to the perfect temperature. But that's not all – they also provide insights into your energy usage, helping you make narter, more eco-friendly decisions. It's convenience and efficiency wrapped into one.

IoT Connectivity

It seems you can't get through a piece of tech news without stumbling over the words "the Internet of Things" (IoT). If you don't



time we made this change too!
2. Smart HVAC Systems and Internet of Things (IoT) Integration

Integration of Smart Thermostats and

From robotic assistants in our homes to omated machines in factories, technology is transforming industries across the board. The HVAC sector is no exception - it's getting on board with the smart home revolu-Thanks to smart thermostats like Nest and Ecobee, you can adjust your home's temalready know, the IoT refers to the concept of connecting everyday devices and objects to the internet so they can send and receive data - essentially allowing them to "talk" to you and to each other. This technology is taking HVAC systems to new heights, enabling heating and cooling equipment to function more efficiently and intelligently.

By connecting HVAC equipment to a network of sensors and devices, buildings can optimize energy consumption like never before. These Contd on page 21



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HVAC System Design: Equipment Selection, and Energy Efficiency

1.1 HVAC SYSTEM

Air conditioning study is one of the most complicated studies and is done in various stages. Heat load calculation takes into account the heat developed due to occupancies as well as the equipment present inside, and also the environmental factors affecting the same. During heating installation, only the heat load calculation has to be performed. But when it comes to HVAC, heat load calculation is accompanied by cooling load calculation. sharing equal importance required for designing the system.

An engineer thus has to have perfect knowledge of the construction, the surrounding environment, occu pancies, etc., concerning the system before actually installing the AC system. The next step will be the selection of appropriate equipment according to the observations obtained through the above analysis. By selecting the proper size and load-taking capacity equipment, the main motto of comfort, along with energy saving, will be attained. If we select an air conditioning system of a larger size than the required



size, then it will lead to high initial as well as high running cost. On the contrary, if the air conditioning system of a smaller size is fitted than the required size, then there will be undercooling and the very purpose of the installation of a system will not be accomplished.

The aim of this paper is to develop or explain the steps required for designing

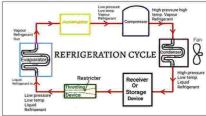
an AC system with proper heat load calculations. The HVAC designer specifies the size of the system which gives maximum efficiency at the lowest running cost. This aim of this paper is accomplished in a few stages. Each stage is explained in detail further. Today, A/C equipment represents close to a \$100 billion, 100 million-unit per year global market, and

accounts for 4.5 exa-joules (4.26 Quadrillion Btu) of site energy consumption per year, comprising just over 4% of global building site-energy consumption. While adoption of A/C in developed countries increased rapidly in the 20th century, the 21st century will see greater adoption in developing countries, especially those in hot and (possi-bly) humid climates with

Brazil and Middle Eastern

The International Energy Agency (IEA) projects that A/C energy consumption by 2050 will increase 4.5 times over 2010 levels for non-Organization of Economic Coordination and Develop-ment (OECD) countries versus 1.3 times for OECD countries. Rising income and greater access to A/C equipment in many of these nations opens the door to building cooling for billions of people, which will provide significant benefits in increased human health and comfort. Therefore, we move towards designing an HVAC

system is an indoor system designed by WILLIAM HAVILLAND CARRIER in 1902 at Sackett-Wilhelms Lithographing and Publishing Company in Brooklyn, New York. An air-conditioning system provides cooling and humidity control for all the parts of the system. An air conditioned system is airsealed in order to maintain constant environmental conditions. Ventilation plays an important role when it comes to the AC system. It is the process of replacing or exchanging air within the system in order to provide high air quality and removal of odours, smoke, heat, and dust that gets accumulated in the system with time.



system for minimizing ener gy utilization and energy lation, and Air-Conditioning

1.2 BASIC REFRIGER-ATION CYCLE

The basic refrigeration Contd on page 17





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HVAC System Design:Equipment Selection, and Energy Efficiency

Contd from page 16 cycle consists of condenser, compressor, evaporator, and expansion valve. A compressor is a mechanical device that increases the pressure of gas at the expense of the volume of gas. These are similar to pumps as both can transport fluids through pipes. Basically, a condenser is a device which condenses a substance from its gaseous state to its liquid state by

Specific Humidity, Indoor-Air-Quality, British Thermal Unit, Ton of Refrigeration.

THE VARIOUS MOD-ULES USED AND THEIR FUNCTIONALITIES ARE DISCUSSED AS FOL-LOWS:

Four requirements are the bases for any HVAC systems [4]. They need primary equipment, space requirement, air distribution, and piping, as shown in Figure.



cooling it. It works on the principle of transfer of latent heat to the surroundings, leading to a change in state

leading to a change in state. Figure 1.2.1 – Refrigeration Cycle

An evaporator is a device used to evaporate the liquid form of a substance into its gaseous form. An expansion valve is one of the most important components of the refrigeration cycle as it controls the amount of refrigerant flowing into the system.

ant flowing into the system. 3.1 PROBLEM DEFINI-TION

The average summer temperatures experienced by most countries are increasing every year, and consequently, the energy needed to provide air-conditioning is also increasing annually. The HVAC industry has a chal-lenging task of providing energy-efficient technologies to satisfy this growing demand with a minimum impact on global warming and ozone depletion. The chilled water types of central air conditioning plants are installed in places where whole large buildings, shop ping malls, airports, hotels, etc., comprising several floors, are to be air-condi-

The project consists of how the proposed centralized air conditioning is designed and its criterion for a new building in Hyderabad. It consists of 6 floors having an area of 4,000 sqft. per floor. The main objective is to create a thermally controlled environment within the space of a building envelope such as kitchen room, master bedroom, dining room, etc. The tentative air conditioning load for the system shall be 290 TR approx. Air-cooled chillers with pumping systems are proposed to make the system energy efficient. The proposed air conditioning plant shall be located on the building terrace.

the building terrace.
Keywords: Humidification, Dehumidification, Infiltration, Ventilation, Dry Bulb
Temperature, Wet Bulb Temperature, Dew Point Temperature. Relative Humidity.

Figure: 3.1.1 HVAC System Requirement

Primary equipment includes heating equipment such as steam boilers and hot water boilers to heat buildings or spaces, air delivery equipment as packaged equipment to deliver conditioned ventilation air by using centrifugal fans, axial fans, and plug or plenum fans, and refrigeration equipment that delivers cooled or conditioned air into space. It includes cooling coils based on water from water chillers or refrigerants from a refrigeration process.

Space requirement is essential in shaping an HVAC system to be central or local. It requires five facilities as the following:

- 1. Equipment rooms: since the total mechanical and electrical space requirements range between 4 and 9% of the gross building area. It is preferable to be centrally located in the building to reduce the long duct, pipe, and conduit runs and sizes, to simplify shaft layouts, and to centralize maintenance and operation.
- tenance and operation.

 2. HVAC facilities heating equipment and refrigeration equipment require many facilities to perform their primary tasks of heating and cooling the building. The heating equipment requires boiler units, pumps, heat exchangers, pressure-reducing equipment control air compressors, and miscellaneous equipment, while the refrigeration equipment requires water chillers or cooling water towers for large buildings, condenser water pumps, heat exchang-ers, air-conditioning equipment, control air compr sors, and miscellaneous equipment. The design of equipment rooms to host both pieces of equipment should consider the size and the weight of equipment, the installation and maintenance of equipment, and the applicable regulations to combustion air and ventilation air

Contd on page 19

Airnest Global Pvt. Ltd.: Redefining HVAC Excellence in Pakistan

Global Pvt. Ltd. is a dynamic extension of a group with deeprooted expertise in the MEP industry, established in 1982.

In 2018, our Board of Directors recognized a growing demand for high-quality, sustainable climate solutions and strategically expanded into the HVAC equipment supply sector. This move marked the birth of Airnest Global Pvt. Ltd., a company built to deliver innovative, reliable, and energyefficient

air conditioning solutions to Pakistan's evolving industrial and commercial landscape.

We are proud to be the exclusive suppliers of globally renowned brands such as Johnson Controls - Hitachi Air Conditioning, SKM Air Conditioning, SKM Air Conditioning, and MESAN. Our offerings combine cutting-edge Japanese technology, world-class performance, and industry-proven durability. This partnership allows us to meet air conditioning needs with unmatched speed, intelligence, and efficiency, setting a new benchmark for HVAC excellence in the

region

Our vision is to be a leading provider of innovative and sustainable solutions by importing premium Hitachi and SKM products, empowering industries to create a cleaner, greener environment for future generations. We are committed to delivering top-tier products that not only enhance operational efficiency but also contribute to environmental sustainability. Our mission is to support our clients in reducing their ecological footprint through advanced HVAC technolo gy and exceptional cus

tomer service. With a strong focus on innovation, quality, and dependability, we aim to drive positive transformation across all sectors we serve.

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organizational structure, dedicated leadership, and a collaborative team culture. Each professional in our team plays a
vital role in fulfilling our
commitment to delivering
exceptional HVAC solutions. Together, we are
shaping a future driven
by sustainability,
innovation, and performance.

DELIVERING EXCELLENCE IN HVAC SOLUTIONS

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At **Airnest Global**, We Specialize In Delivering Top-Tier HVAC Solutions Tailored To Meet The Evolving Needs Of Diverse Industries.

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Our mission is to provide reliable and innovative **HVAC** solutions that enhance operational efficiency and comfort.

Our vision is to be the go-to partner for businesses seeking advanced **climate control** systems driven by a commitment to quality and customer satisfaction.







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For more updates, project highlights, and industry insights, stay connected with Airnest Global. Reach out to us today to explore how we can optimize your HVAC systems.









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"Karachi's Water Crisis: Between Mafia Control and Missed Opportunities"PEF Seminar Exposes Systemic **Failures While Proposing Viable Solutions**

braces for another scorching summer, its perennial water crisis looms larger than ever. The recent seminar

The consensus was clear: Karachi's thirst can only be quenched through urgent, collective action.

The Grim Reality The seminar's opening Javed Bilwani (President

Al Kazim Mansoor (Former PEF President) pulled no punches in exposing the

water tanker mafia's opera tions, revealing how this illegal industry has institutionalized water scarcity for profit.

The discussion then

turned to potential solutions The K-4 Project: Hope Delayed

Dr. Bashir Lakhani, overseeing the crucial K-4 project, presented progress

funding delays that keep pushing completion time lines. He also emphasised Sindh Government's inability to augment the distribution network for these additional 650 MGDs of water to

Trade & Industry (KATI)) expressed frustration at the Sindh government's neglect of Karachi, the city that welcomes and sustains millions, "Why," he asked. "does Pakistan's economic engine get treated this way?









organized by the Pakistan Engineers Forum (PEF) laid bare the harsh realities from the tanker mafia's stranglehold to bureaucratic inertia - while charting potential pathways to water security.

KCCI) paid tribute to Karachiites' resilience in enduring chronic water shortages, highlighting how water new normal for Pakistan's

His revelations painted a picture of systemic exploitation where citizens pay premium prices for what should be a

Technical Solutions on

updates on this 650 MGD initiative meant to bring Indus water to Karachi. While technical hurdles were acknowledged, the bigger challenge appears to be

Karachiites at their house line nozzles.

Groundwater Recharge: A Partial Answer

Dr. Imran Ahmed (NED University) made a com-pelling case for large-scale groundwater recharge systems. His presentation demonstrated how rainwater harvesting and managed aquifer recharge could supplement supplies, though he cautioned that these measures alone couldn't meet the megacity's massive demand.
3. The Management

Deficit

Prof. Dr. Shahid Saleem analyzed the root causes of water shortages. emphasizing that while infrastructure matters, poor management exacerbates the crisis. His data showed how unplanned urbanization and outdated distribution systems lead to massive water losses. The Corruption Ele-

phant in the Room

Senior journalist Monis Ahmed delivered perhaps the most damning indictment, tracing how corruption permeates every level of water governance. From illegal hydrants to political patronage of tanker operations, his exposé revealed why technical solutions alone won't solve Karachi's

Industry Leaders Speak Out

Junaid Nagi (President, Korangi Association of

A Call for Collective Action

The seminar's most resonant message came from Monem Zafar Khan (Jamaat Islami Karachi Chief), who stressed that water transcends political divisions His appeal for stakeholders to unite beyond party lines struck a chord, emphasizing that Karachi's survival depends on putting people

before politics.
The Path Forward The solutions framework that emerged demands:

- · Immediate crackdown on water mafias and corrupt practices
- Fast-tracking K-4 with transparent oversight
- Large-scale conserva tion and recharge initiatives
- Inclusive governance involving all stakeholders

As shields were awarded and participants depart-ed for high tea, one question lingered: Will this seminar join Karachi's long history of forgotten dialogues, or will it spark the movement that finally brings water justice to the city? The technical solu-tions exist. The crisis is understood. How many more seminars will it take before Karachi gets the water it deserves? The solutions exist. The crisis is understood. What remains is the hardest part - mustering the political will to act.

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The cooling dilemma amid climate change

Are air conditioners the solution to heat, or the cause?

ecord heat blanketed much of the globe in the Summer of 2023. The planet is already 1.1°C hotter compared to the average temperature in 1850-1900.

Hot extremes including heat waves have become more frequent and intense since the 1950s. At this pace, global average temperaturare estimated to rise 1.5°C

air-conditioners are in opera tion globally, and with the growing demand for colling, two-thirds of households could have an air conditioner by 2050. However, the current cooling systems have low technical and systemic efficiency, which coupled with increasing use, strain power grids and contribute to greenhouse gas (GHG) emissions. Despite the increase in the use of air-conditioners, due to socioeconomic disparities, those who need cooling

minating in an estimated 300,000 fatalities. Vulnerable groups like children, the elderly, outdoor workers, and those in poorly insulated housing are at higher risk. Urban areas with dense infrastructure and limited green spaces can become especially hot. Additionally, individuals with limited mobility, social isolation, and without effective indoor cooling are also at an elevated risk of heat-related

Air-conditioning is a life-



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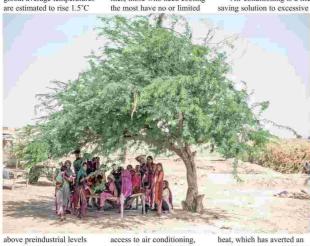
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above preindustrial levels sometime between 2030-2035. By 2030, an estimated 500 million people globally, particularly in regions like South Asia and the Middle East, will be exposed to extreme heat at least 30 days or more per year, and the number of people enduring highly dangerous heat (over 120°F on a dry day, or around 95°F on a humid day), is projected to quadru-ple by 2030.

Aligned with these trends, over the past decade, the energy demand for space cooling has grown more than twice as fast as the overall building energy demand. Currently, roughly 2 billion

access to air conditioning, putting them at risk of heat exhaustion and possibly even death. This explainer highlights critical trade-offs between existing mechanisms of cooling and its social and environmental implications. We examine the challenges and dilemmas around mechanical cooling and its implications for children.

The cooling conundrum Excessive heat poses severe health risks, including heat-related illnesses and fatalities. In the past 20 years, the annual average count of heat-related fatalities among individuals aged 65 and older surged by a staggering 61 per cent, cul-

heat-related deaths annually during 2019-2021. Epidemic logic studies have shown that having household air conditioning reduces the risk of heat-related deaths by approximately 75 per cent compared to those without it. However, cooling systems have their downsides as Contd on page 28

estimated average of 190,000

HVAC System Design: Equipment Selection, and Energy **Efficiency**

Contd from page 17

Fan rooms contain the HVAC fan equipment and other miscellaneous equipment. The rooms should consider the size for the installation and removal of fan shafts and coils, the replace ment, and maintenance. The size of fans depends on the required airflow rate to condition the building, and it can be centralized or localized based on the availability, location, and cost. It is preferable to have easy access to outdoor air.

4. Vertical shaft: pro-

vides space for air distribution and water and steam pipe distribution. The air distribution contains HVAC supply air, exhaust air, and return air ductwork. Pipe distribution includes hot water, chilled water, condenser water, and steam supply, and condenser return. The vertical shaft includes other mechanical and electrical distribution to serve the entire building. including plumbing pipes. fire protection pipes, and electric conduits/closets.

Equipment access the equipment room must allow the movement of large, heavy equipment during installation, replacement, and maintenance.



Schneider Electric Pakistan Celebrates Key Partnerships

tric Pakistan recently hosted its highly anticipated Innovation Talk: Part-

resellers, retailers, and panel builders, marking a significant celebration of their pivotal role in the resounding success of the Schneider Electric Mega Sale Cam-

The event underscored the indispensable role of Schneider Electric's robust partner network in driving market leadership and delivering unparalleled value to cusunwavering dedication that propelled the Mega Sale 2024 to a triumph in the dynamic city of Karachi.

"This event was a powerful testament to the strength

partners in Karachi are instrumental in fuelling our shared vision for a more electrified and sustainable future. We extend our sincerest gratitude to

scape in Pakistan, he

Schneider Electric Pakistan remains committed to fostering strong, mutually beneficial rela-



nerships of the Future event in Karachi.

The exclusive gathering welcomed over 100 esteemed distributors, their dedicated

paign 2024.

The Innovation Talk served as a profound acknowledgment of the exceptional contributions made by these vital partners.

tomers across the region Achievements from both the direct "Sell-in" campaign and the broader "Sell-out" efforts were recognized, celebrating the strategic acumen and

of our partnerships," stated Mr. Kamran Sultan, Country Leader for Panel Builder & Distribution. The drive and commitment from each of our

all who joined us, and we eagerly anticipate deepening these vital collaborations as we continue to innovate and collectively shape the industry landtionships with its partners, recognizing that their success is paramount to the company's mission of empowering all to make the most of their energy and resources. - PR



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ment and Skills Gap

Need for Skilled Profes

With all these technologi-

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HVAC professionals are in

high demand. There's a grov

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who are trained in the latest

technologies, AI integration

and renewable energy solu-

and industry organizations

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installation and maintena

efficiently and safely.

certifications.

are stepping up by offering

tions. Educational institutions

Investing in workforce

HVAC techs are equipped to handle modern HVAC repair,

Market Expansion The HVAC market is

booming, thanks to urbaniza-

tion and new construction

systems, including smart

Top 21 HVAC Industry Trends and Innovations to Watch in 2025

Contd from page 14 smart systems can

Adjust temperatures based on room occupancy, ensuring you're not wasting energy heating or cooling empty spaces.

Manage energy use durng peak times to lower your bills and reduce strain on the power grid.

Learn your comfort preferences and automatically adjust settings - even when you're not home

3 Artificial Intelligence (AI) and Predictive Mainte-

AI-Powered Systems Remember when 'AI' was nothing more than a Steven Spielberg flick star ring that wee boy who could "see dead people"? Well, now AI is writing our emails driving our cars, and even suggesting what we should binge-watch next.

It's also revolutionizing HVAC systems, making them smarter and more reliable. AI algorithms analyze data from your system to predict potential issues before they

become big problems.

This predictive maintenance approach means fewer unexpected breakdowns and a longer lifespan for your equipment. Plus, AI can optimize system settings in realtime for maximum efficiency, learning from your usage patterns and adjusting operations to match. And you won't even need to lift a fin-

ger. How cool is that? 4. Enhanced Indoor Air Quality (IAQ)

Focus on Health and Wellness

Nothing like a pandemic to permanently ingrain the

importance of indoor air quality into our psyche

Poor indoor air quality is bad news - it can trigger allergies, worsen conditions like asthma. and even facilitate the spread of airborne diseases, HVAC systems are now incorporating advanced filtration technologies, such as HEPA filters and UV-C light

purification, to emove contami nants from the air. Improved ventilation brings in fresh air, turning our homes and workplaces into healthier environments

These advancements not only create a safer and more comfortable space for us but also provide that precious peace of mind we all crave

5. Renewable Energy Integration

Solar-Powered HVAC Systems

Energy production from coal, oil and gas contributes significantly to global warm ing - we all know this But did you know that fossil fuel account for about 75% of global greenhouse gas emis sions and nearly 90% of all carbon dioxide emissions? This is why integrating renewable energy sources like solar, wind, water, wa and geothermal heat into global energy systems is absolutely crucial for mitigat ing climate change and building a sustainable future.

With many countries i

solar energy, these systems reduce reliance on the grid and cut electricity costs dramatically. Some even allow you to sell excess energy back to the grid. Now that's what we call environmental and financial sense!

6. Regulatory Changes



HVAC systems are becon more accessible and efficient than ever. By harnessing

ing to achieve net-zero emis-

s by 2050, solar-powered

Stricter Energy Regula-

7. Workforce Develop-

Governments worldwide are enacting stricter energy efficiency regulations to combat climate change These regulations affect how HVAC systems are designed, manufactured and installed.

For businesses, staying ahead of these

regulations not only avoids penalties but also positions them as leaders in sustainability. Upgrading to compliant equipment not only keeps you on the right side of the law but can also lead to significant energy savings. It's a step forward for

projects worldwide. As more people move into cities and buildings

Contd on page 22

Pakistan HVACR Expo 2025: Ushering a New Era of Sustainable Innovation

Contd from page 11 strategic platform for trans-

"This Expo is more than an exhibition—it's a catalyst for business development innovation, and global integration. We've worked tire-lessly to grow our Society, strengthen ties with govern-ment and international partners like ASHRAE, and advocate for a progressive. future-ready HVACR indus try.

The President also highlighted key engagements with bodies such as NEECA, the Ministry of Climate Change, EDB, and PEC, underscoring the Society's active policy role

Sved Fakkhi Iftikhar. Chairman of the Islamabad Chapter, echoed similar sentiments:

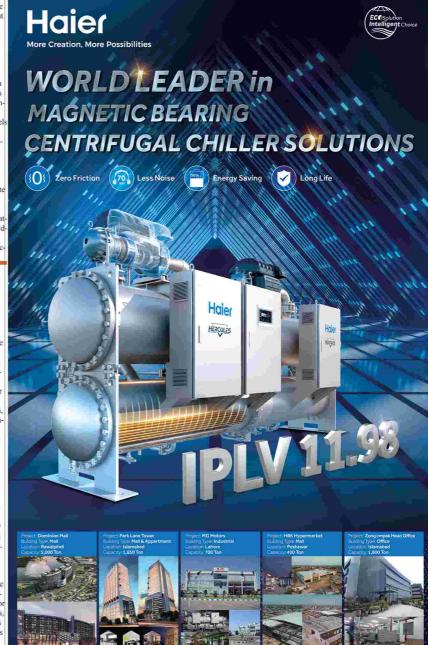
"Post-COVID the HVACR field has evolved drastically. Health, environmental standards, and energy efficiency are top priorities now. This Expo brings new technologies that local SMEs and startups can learn from.

replicate, and even introduc to global markets.'

Why This Expo Matters In an era of rapid urbanization and climate challenges, HVACR is no longer a support sector-it is central to smart building design urban resilience, and susta able development. This year's exhibition showcases breakthrough technologies that redefine how buildings are cooled, ventilated, and made energy-efficient.

From Al-enabled building systems to smart grid integration in HVACR solutions, visitors can expect a comprehensive view of how the industry is aligning with global green building trends Looking Ahead

With the credibility of nearly three decades and a forward-looking strategy, the Pakistan HVACR Expo continues to set benchmarks. For manufacturers, professionals academia, and policymakers alike, the 2025 edition offers unmatched opportunities to network, learn, and lead, -ER Report



Top 21 HVAC Industry Trends and Innovations to Watch in 2025

Contd from page 21

mand for modmore advanced, the de ern HVAC systems grows. This expansion brings more options and innovations to consumers. It's an exciting era with lots of opportunities for both industry professionals and customers looking for the latest and greatest in comfort technology.

9. Advanced Building Automation Sys-

Integration with Building Management Systems (BMS)

Building Management Systems (BMS) are becoming the brains behind modern buildings

By integrating HVAC systems with BMS, facilities can achieve optimized performance and significant energy savings. These systems allow for centralized control of heating, cooling, lighting and other building functions. They use data analytics to monitor performnce, detect anomalies and adjust operations in real-time.

The result? A comfortable, efficient environment that responds dynamically to occupants' needs and external condition

10. Advanced Air Filtration and Purification Technologies

Response to Air Quality Issues | UV-C Light Technology

With increasing concerns over air pollution and health hazards like wildfires, there's a heightened demand for advanced air filtration systems.

Modern HVAC systems now feature multi-stage filters that tackle everything from dust and pollen to harmful VOCs. And let's not forget about UV-C Light Technology using ultraviolet light to eliminate bacteria and viruses.

These advancements mean cleaner. healthier air in our homes and workplaces Breathing easy has never been so attainable! 11. Virtual and Augmented Reality

(VR/AR) in HVAC Training and Maintenance

Enhanced Training Programs Boring training sessions are a thing of the past - at least in HVAC. Virtual and Augmented Reality are transforming the industry, making training more interactive and engaging. VR provides immersive simulations where technicians can practice in virtual environments, learning how to install and repair systems without the risk of real-world mis-

Remote Maintenance Support

cant environmental challenges. How so? Data centers, the backbone of the internet, process vast amounts of data every time we go online, operating hundreds of thousands of servers

This continuous activity generates an incredible amount of heat, requiring these servers to maintain optimum temperatures to function without interruptions or system failures. In fact, up to 1.5% of global electricity consumption in data centers is attributed to energy-intensive cooling systems.

This is why innovative HVAC solutions are becoming crucial for data centers to manage energy consumption and reduce their carbon footprint.

Technologies such as precision cooling, liquid cooling and hot aisle containment efficiently manage heat loads, ensuring optimal performance. Advanced HVAC systems not

rized access can lead to operational disruptions, compromised building security, and even threats to occupant safety. Hence the implementation of robust cybersecurity measures is crucial. This includes adopting secure network protocols, ensuring regular software updates, utilizing encryption and providing employee training on best practice

These security strategies not only safeguard the HVAC systems but also protect the privacy and safety of building occupants. By prioritizing cybersecurity, businesses can ensure uninterrupted operations, protect sensitive data and maintain trust with their occu-

14. Use of Drones and Robotics in HVAC Maintenance Inspection Efficient Maintenance

We're all familiar with drones being used for courier deliveries, military operations, filmmaking or capturing stunning aerial images. Similarly, robotics have become inte-

gral to modern manufacturing. But guess what? These cutting-edge technologies are now rapidly transforming HVAC maintenance, especially in large or complex facilities where upkeep poses significant chal-lenges. Imagine a drone gracefully navigating the intricate maze of ductwork in a sprawling industrial building, capturing high-resolution images and pinpointing areas that need atten-

Equipped with advanced cameras and sen-sors, drones and robots can detect issues such as leaks, corrosion or blockages without putting human safety at risk. This innovative approach not only enhances efficiency and reduces downtime but also delivers detailed data that informs more effective maintenan

By leveraging drones and robotics, HVAC maintenance is becoming smarter, safer and more precise than ever before.

15. Water Conservation in HVAC: Heating and Cooling Systems

Hydronic Heating and Cooling Water conservation is becoming a key focus in HVAC innovations, and hydronic

Contd on page 23



Remote Maintenance Support is also a game-changer. Imagine a technician on-site getting real-time guidance from an expert away through AR glasses. How cool is that? Not only does this technology reduce errors and saves time, it also enhances safety.

This hands-on experience accelerates ng and improves retention

12. HVAC Systems for Data Centers Critical Cooling Solutions

A life without the internet is unimaginable but this essential utility comes with signifi-

only help reduce operational costs and environmental impact but also enhance the reliability and longevity of data center equipment.

13. Cybersecurity in HVAC Systems

Protecting Connected Systems

As our lives become more connected and digitally savvy, we're increasingly vulnerable to cyber threats. It's a harsh reality, but staying informed and vigilant is essential to protect ourselves and our loved ones.

With HVAC systems integrating more IoT and smart technologies, cybersecurity has emerged as a significant concern. Unautho-



Top 21 HVAC Industry Trends and

Innovations to Watch in 2025

Contd on page 22 heating and cooling systems are leading the way.

Unlike traditional air based systems, hydronic systems use water to transfer heat, which is inherently more efficient and requires less energy. By leveraging closed-loop water circuits. these systems minimize water waste and optimize

usage.
Additionally, hydronic systems can integrate seam-lessly with renewable energy sources, further reducing their environmental impact. With precise temperature control and zoning capabilities, hydronic heating and cooling not only enhance comfort but also significantly lower water and energy con-

Embracing hydronic technology is a smart move toward a sustainable and effi-

16. Geothermal HVAC

Harnessing Earth's Ener-

Geothermal HVAC systems harness the earth's stable underground tempera-tures to efficiently heat and cool buildings. By using a series of underground pipes, these systems transfer heat between your home and the earth, significantly reducing energy consumption compared to traditional HVAC

Not only do geothermal systems offer exceptional energy efficiency, but they also provide long-term cost savings and a minimal environmental footprint.

Advances in geothermal technology have made installations easier and more affordable, increasing their accessibility for both residential and commercial proper-ties. As sustainability becomes a top priority, geot-hermal HVAC systems are emerging as a reliable and eco-friendly solution for year-round comfort.

17. Legislative Incentives and Tax Credits

Financial Incentives for Upgrades

The race to meet Net Zero targets is heating up (pun fully intended), and governments are calling on all industries to contribute to reducing CO2 emissions. To encourage the adoption of energy-efficient and renewable energy technologies, governments offer various financial incentives, including tax credits, rebates, lowinterest loans and grants

For homeowners and businesses, these incentives lower the upfront costs of upgrading HVAC systems, making it more feasible to invest in advanced technologies like smart thermostats, high-efficiency furnaces and geothermal systems

This is a fantastic opportunity to embrace modern. efficient technology while keeping some extra cash in your pocket, isn't it? Plus, by upgrading, you're not only saving money but also con tributing to a greener planet.

Remember to check out what's available in your area you might be pleasantly

changing conditions, keeping your home cozy during unex-pected heat waves or chilly

automatically adjust heating



nights. These smart systems use real-time data and advanced algorithms to

HVAC-as-a-Service (HVACaaS)

Subscription-Based Models

Having a top-notch HVAC system often comes with a steep price tag, and

many businesses prefer to avoid hefty upfront costs. Enter HVAC-as-a-Service (HVACaaS) as the solution. This subscription-based model offers heating and cooling solutions that cover installation, maintenance and updates for a monthly fee – just like your Netflix subscription. It eliminates the need for large upfront investments and ensures systems are always equipped with the latest technology and efficiency standards, maintained by expert HVAC techni-

HVACaaS provides flexibility and peace of mind, making advanced HVAC systems more accessible to a wider market. - Sophie Liu



18. Biomimicry: Future of the HVAC Industry

Nature-Inspired Solution Nature has long served a a blueprint for technological innovation, with engineers and scientists drawing inspiration from animals and plants to solve human challenges. This process, known as biomimicry, has led to breakthroughs like Velcro, inspired by burrs clinging to fur, and aerodynamic trains nodeled after kingfisher

In HVAC, this could mean designing systems that mimic how termites cool their mounds or how certain plants manage water evaporation. These nature-inspired solutions can lead to more efficient and sustainable HVAC designs.

19. Acoustics and Noise

Quieter Systems "Oh, I absolutely LOVE

the comforting hum of A/C systems," said no one everexcept maybe that one neardeaf person somewhere in the Aussie outback during th peak of summer.

Let's face it, most of us wish for a magic wand to make that annoying A/C noise disappear forever Noise pollution is an often overlooked aspect of HVAC systems, but advances in

technology are changing that Modern systems are becoming quieter, enhancing occupant comfort through improved fan designs, better insulation and vibration dampening materials. Quiete HVAC systems are especially important in residential settings, hospitals, schools and offices where excessive nois can be disruptive or detrimental to well-being. A qui-eter system definitely makes a world of difference!

20. Climate-Adaptive HVAC Systems

Systems Designed for Extreme Weather

How cool would it be to have an HVAC system that not only keeps you comfortable today but also adapts to the unpredictable weather of tomorrow? Well, guess what HVAC systems are now embracing climate-adaptive technologies to respond to

"The ideal engineer is a composite ... He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems."

N. W. Dougherty (1955)

since

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A New Era of Cooling: Innovation, **Equity, and the Climate Crisis**

his past July was the hottest recorded month in human history. Heat waves smashed temperature records worldwide and even brought summer temperatures to Chile and Argentina during the Southern Hemisphere's winter.

It's more than just a matter of sweaty discomfort. Severe heat is the deadliest of all weather events; in the U.S. alone, it kills more people each year than floods. tornadoes and hurricanes combined. As climate change cooled spaces is rapidly becoming a health necessity-and an issue of basic human rights.

Yet standard air-conditioning systems have ensnared us in a negative feedback loop: the hotter it is, the more people crank the AC—and the more energy is used (and greenhouse gases are emitted) as a result. "We're in a vicious cycle," says Nicole Miranda, an engineer researching sustainable cooling at the University of Oxford. And "it's not only



a vicious cycle, but it's an accelerating one." Cooling is the fastest-growing single source of energy use in build-

business-as-usual scenario the IEA projects that worldwide annual energy demand from cooling will more than triple by 2050. That's an about how much energy the entire U.S. uses in a year.

It's becoming increasingly clear that humans cannot

come from the energy used to power it, says Nihar Shah, director of the Global Cooling Efficiency Program at Lawrence Berkeley National

from the International Energy Agency (IEA). Following a

increase of more than 4,000 terawatt-hours, which is

the same air-conditioning technology we've been using for nearly a century. Breaking the cycle requires new innovations that will help bring cooler air to more people with less environmental impact.

One well-known problem with current AC systems is their reliance on refrigerant chemicals, many of which are potent greenhouse gases. Some projects aim to replace these substances with lessharmful coolants-but even if they do, the refrigerants make up only a fraction of air-conditioning's climate toll. About 80 percent of a standard AC unit's climate warming emissions currently

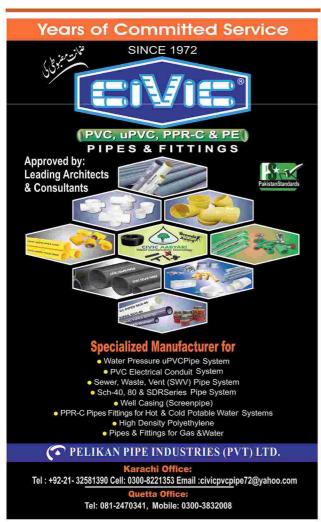
Laboratory. A lot of recent work has gone into boosting the energy efficiency of compressors and heat exchangers. which are parts of standard AC designs, Shah explains. Yet more ambitious projects aim to reduce the amount of work those components must do in the first place.

Standard air-conditioning systems simultaneously cool and dehumidify through a relatively inefficient mechanism: in order to condense water out of the air, Shah says, they overcool that air past the point of comfort. Many new designs therefore separate the dehumidification and cooling processes, which avoids the need to overcool.

For example, some newer air conditioner designs pull moisture from the air with desiccant materials (similar to the silica gel in the packets you might find in a bag of jerky or a bottle of pills). The dried air can then be cooled to a more reasonable temperature. This process can require some additional energy because the desiccan needs to be "recharged" using heat. But some companies, including the Somerville, Mass,-based start-up Transaera, recycle the heat generated by the cooling process to recharge the desiccant. Transaera claims that the system it is developing could use 35 percent less energy than the average standard AC unit.

Even bigger efficiency gains are possible when dehumidification is paired with evaporative cooling, which takes the energy-intensive process called vapor compression out of the equation altogether. Vapor compression-the system by which standard AC works moves a refrigerant through a cycle in which it is variably condensed and expanded, enabling it to absorb heat from inside and release that heat outside. Conversely, evaporative cooling is a sim-pler process. It's the same one through which sweating cools our skin: as water goes from liquid to gas, it absorbs heat. Swamp coolers, DIY devices in which a fan blows air over ice, work the same way. And in dry climates, people have used evaporative cooling for thousands of years. In ancient Iran, for instance, people engineered vakhchäls-large, coneshaped clay structures with solar chimneys-which harnessed air circulation and the evaporation of adjacent water to lower temperatures so much that they could make

Contd on page 25





Nexus Fire Solutions: Pioneering a Safer Tomorrow

INTRODUCTION

Nexus Technical Solutions (Pvt) Ltd., operating under the brand name Nexus Fire Solutions, was established in 2024 as a forward-thinking initiative born from a strong legacy. Rooted in a consortium of family-owned businesses that have been active in the construction, engineering, trading, and retail sectors since 1982, Nexus Technical Solutions brings over four decades of multisectoral experience into a unified mission: to revolutionize the fire safety industry in Pakistan.

t Nexus Fire Solutions, we are com-

mitted to making constructed spaces safer and more efficient through the

delivery of innovative fire safety products and engineered

solutions. Our vision is centered around the well-being of mankind, ensuring that life and property are protected through smart, reliable, and futureready fire protection systems.

As an Authorized Partner and representative for several globally recognized fire safety brands, Nexus has become a trusted name for quality and reliability in the local market. We proudly serve as the official representatives

of industry leaders such as Duyar, SFFECO Global, Defender, Finder Pemall USA and Tyco, providing advanced fire suppres-sion, detection, and protection systems tailored to Pakistan's growing safety needs.

In addition to these

strategic alliances, Nexus Technical Solutions also represents a wide range of reputable brands that complement our fire safety ecosystem. These include Izocam (thermal insulation solutions), Grundfos (world-class pump systems), Multivent (ventilation solutions), and Saba Air Devices (air movement and distribution technologies), all of which support our mission of delivering holistic and efficient building safety systems

With a strong foundation, diverse expert-ise, and a visionary approach, Nexus Technical Solutions (Pvt) Ltd. is poised to lead the way in fire safety and building solutions across Pakistan, empowering industries, protecting lives, and facilitating progress through innovation and trust

A New Era of Cooling: Innovation, Equity, and the Climate Crisis

Contd from page 24 ice in winter and store it through summer.

But this strategy also increases air's humidity, so as a cooling system, it tends to work only when the weather is hot and dry; if humidity rises beyond a certain point, it cancels out the comfort gains of reduced temperature. To solve this. research groups, including Harvard University's cSNAP team, have designed AC devices that use a hydrophobic barrier to perform evaporative cooling while holding back humidity. As a bonus, refrigerants-which are often greenhouse gases that are many times more potent than carbon dioxide—aren't involved at all. "We expect to provide a 75 percent more energy-efficient air conditioner," says Jonathan Grinham, an assistant professor of architecture at Harvard and one of cSNAP's lead designers.

Meanwhile Florida based company Blue Fron-tier is trialing a commercial air-conditioning system based on both a desiccant (in this case, a liquid salt solution) and evaporative cooling. This design dries the air and then splits it into two adjacent streams, explains the company's CEO, Daniel Betts. The air in one stream is directly cooled through the reintroduction of moisture and evaporation. The other airstream is kept dry, and it is cooled by being run across a thin aluminum wall that pulls in the coldbut not the humidity-from the first stream. The liquid salt desiccant then runs through a heat pump system to be recharged. To maximize efficiency, the heat pump can be run at night, when the power grid is least stressed, and the desiccant can then be stored for use in the hottest part of the day. Based on the company's field trials, "we're looking at 50 to 90 percent

reductions in energy consumption," Betts claims.

But Blue Frontier. cSNAP and Transaera have yet to go from testing to mar-ket. All three groups predict they're at least a couple of years away from commercial launch. And even then, there will be obstacles that could prevent the new systems from replacing traditional ACs. These include relatively higher manufacturing and installation costs, industry inertia and policies that incentivize cheap systems over efficient ones.

Even with some of the best technologies available, the gains in efficiency alone might not be enough to offset the widely expected uptick in air-conditioning use. Under the best-case model, the IEA projects that cooling worldwide will require 50 percent more energy in the next 25 years than it does now because of rising demand. Shah says. It will not work to simply replace every existing air conditioner with a better model and call it a day. Instead a truly cooler future will have to employ other, passive strategies that rely on urban planning and building design to minimize the need for cooling in the first place. Bringing greenery and water bodies into cityscapes. shading windows, positioning new buildings to take advantage of natural airflow and retrofitting buildings with better insulation and reflective panels that can send heat into space are all critical, both Shah and Miranda say.

"Cooling is a multi-faceted challenge," says Sneha Sachar, an energy efficiency expert at the nonprofit organization Cli-mateWorks. "There isn't one strategy or one answer." We need a combination of better buildings and cities, better technology and a better understanding that the true cost of air-conditioning extends beyond elec-tric bills. "What we do in one part of the world impacts the whole global environment," Sachar says. - SA



STAY CONNECTED. STAY INFORMED

Nexus Technical Solutions Pvt Ltd. is a trusted provider of specialized engineering solutions across Pakistan. With a focus on HVAC, fire protection systems, and technical equipment, we deliver innovative, reliable, and efficient solutions tailored to meet industrial and commercial needs. WHERE COMFORT MEETS COMPLIANCE.



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Cutting-Edge Technology Could Massively Reduce the Amount of **Energy Used for Air Conditioning**

bus company couldn't work it out. Some days when its buses merely crawled along Shanghai's streets, their power consumption would go through the roof.

The reason why was a mystery. So, a team from the US firm Montana Technologies flew out to investigate. They started clamping electricity meters onto parts of the bus and soon realized what Yutong Bus, the Chinese company in question,

had missed.
"They didn't instrument air conditioning," says Matt Jore, CEO of Montana Technologies, explaining how the buses' AC, used to counter the often hot and humid weather in Shanghai, had a huge effect on power consumption. "The driver would turn the air conditioning on, it would just spike up."

Whenever anyone, any where, reaches for the button that activates air conditioning, or lowers the desired



temperature in their room a degree or two, energy use rises. A lot. In humid conditions, air conditioners have to work especially hard—more than half of the energy they

me can go toward dehumidifying the air rather than cooling it. The buses struggling in China's muggy weather gave Jore and his colleagues an idea. If they

could make dehumidification more efficient somehow, then they could make air conditioning as a whole much more efficient, too. They headed back to the US won

dering how to make this hap Cooling devours one-

tenth of the world's energy, or 20 percent of all energy used in buildings. The International Energy Agency expects demand for cooling to skyrocket in the next 25 years—with two-thirds of the world's households expected to have an air conditioner of some kind by 2050. As the climate crisis deepens, judicious use of cooling will only be more important. For one thing, it has the potential to save many lives. But air conditioners, for all their usefulness, are far from sustainable Cooling tech could, in principle, be far more efficient.

"I have here 50-gallon barrels of this stuff. It comes in a special powder," says Jore, referring to the moisture-loving material that coats components inside his firm's novel dehumidifier system, AirJoule, This is the result of years of research and development that followed his team's trip to China. The coating is a type of highly porous material called a metal-organic frame work, and the pores are sized so that they fit around water molecules extremely well. It makes for a powerful desiccant, or drying device.

Contd on page 27





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Cutting-Edge Technology Could Massively Reduce the Amount of Energy Used for Air Conditioning

Contd from page 26

"Just one kilogram can take up half or more than half—in our case 55 percent—of its own weight in

water vapor," says Jore. The AirJoule system consists of two chambers, each one containing surfaces coated with this special material. They take turns at dehumidifying a flow of air. One chamber is always drying air that is pushed through the system while the other gradually releases the moisture it previously collected. A little heat from the drying chamber gets applied to the mois ture-saturated coating in the other, since that helps to encourage the water to drip away for removal. These two cavities swap roles every 10 minutes or so, says Jore

This process doesn't cool the air, but it does make it possible to feed dry air to a more traditional air conditioning device, drastically cutting how much energy that secondary device will use. And Jore claims that AirJoule consumes less than 100 watt-hours per liter of water vapor removed— potentially cutting the energy required for dehumidification by as much as 90 percent compared to a traditional dehumidifier.

dehumidifier.

Montana Technologies wants to sell the components for its AirJoule system to established HVAC firms rather than attempt to build its own consumer products and compete with those firms directly—it calls the approach AirJoule Inside. The firm is also working on a system for the US military, based on the same technology, that can harvest drinkable water from the air. Handy for troops stationed in the desert, one imagines. However, AirJoule is still at the prototype and testing stages.

"We're building several of these pilot preproduction units for potential customers and partners," says Jore. "Think rooftops on big-box retailers."

Rival firm Blue Frontier has also come up with a desiccant-based dehumidifying system, though it uses a liquid desiccant, a salt solution that is capable of collecting moisture from the air. CEO Daniel Betts says that his firm is installing the tech at multiple undisclosed locations around the US—including office spaces, warehouses, and restaurants. Three are live, with six more to be installed by the end of the year.

As with AirJoule, Blue Frontier's approach would link to a separate, secondary air-conditioning process to cool the dried air. And Blue Frontier must similarly factor in the need to regenerate its desiceant, though this process can be separated out from dehumidification and run at times when there is less demand on the electricity grid. "We are shifting the

load of air conditioning from the peak," says Betts.

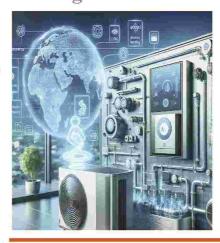
Really big air-condition ing systems work differently to the unit that you might have in your house or apartment. Take centralized chiller plants in hotels, for instance They circulate chilled liquid to guests' rooms where it is used to cool the air. Chiller plants that drop the temperature of this liquid are reasonably efficient already. But they still have to draw power from the grid at peak times, say in the late afternoon, when everyone wants to cool down from the heat of the day, notes Yaron Ben Nun founder and chief technology officer at Nostromo Energy, which focuses on energy

To get around this issue, Nostromo has created a sys tem called IceBrick, which it installed last year at two adjacent hotels in California the Beverly Hilton and the Waldorf Astoria Beverly Hills. The IceBrick, a rectar gular module, sits on the roof of a building. It contains nearly 200 insulated capsules of water that can be frozen when off-peak energy is available. Then, in the middle of a hot day when hotel guests begin to swelter, the chiller plant can use that stored coolth, as it were, to avoid paying top electricity prices. This doesn't mean a reduction in energy consumption-actually, it goes up slightly—but Ben Nun says the system can reduce annual cooling costs by 30 percent and associated emis sions by up to 80 percent, because the IceBrick can wait to draw power at times when lots of renewable electricity is available on the grid (for instance, when wind turbines are busily spinning in the middle of the night)

The system wouldn't suit a single house, as it only works with these large centralized cooling installations. However, it can be bolted to a variety of chiller plants—it doesn't really matter what circulating fluid they use, for example. Ben Nun says.

"It was really exciting to see that," says Nicole Miranda, senior research associate in sustainable cooling at the University of Oxford. "It's nice to see an off-the-shelf, quite stackable, flexible solution."

Not every scenario will require a brand-new approach. Traditional airconditioning technology can benefit from better design, argues Vince Romanin, CEO of Gradient, which makes window-based heat pumps that can provide heating or cooling to a specific roo The units hang either side of window sills, internally and externally, and are connected by pipes. The external part of the unit is larger than is common for traditional air conditioners, which means it can incorporate a bigger, more efficient heat exchanger, says Romanin. But he stresses that



trying to make the most efficient air conditioner possible wasn't a key goal for the company. Rather, it was "getting high-efficiency systems into more types of buildings."

On top of such gains, smart controls and other features can also help ensure users don't waste energy, he notes. A typical Gradient window heat pump currently costs \$3,800, but Romanin says the firm hopes to reduce this to \$1,000 eventually, in order to make the device as accessible as possible.

"I cannot imagine living without air conditioning. I would not be able to work," says Jaka Tušek, assistant professor in mechanical engineering at the University of Ljubljana in Slovenia. Temperatures in Slovenia have recently hovered around 35 degrees Celsius (95 degrees Fahrenheit). And yet, many non-centralized air conditioners today only function at

around 20 percent of their theoretical maximum efficiency, he notes.

An overheating world is going to need more active cooling-of that, there is no doubt. But exactly how and to what extent we deploy it is going to matter. There is no point over-cooling ourselves either. Eva Horn, professor of German literature and cultural theory at the University of Vienna, called out the irony of doing so in her 2016 essay on air conditionin We are getting less and less able to tolerate the very same warming temperatures that we are creating, largely through the massive CO2 output of air conditioning technology itself."

That makes it imperative to find ways of reducing energy consumption on airconditioning overall. All of the above technologies are versions of, or adjuncts to, established air-conditioning

Contd on page 28



Cutting-Edge Technology Could Massively Reduce the Amount of Energy Used for Air Conditioning

Contd from page 1

technology. But there are ideas floating around for how to make an air conditioner of a completely different design. Among the options that excite Tušek is "elec-trocaloric" cooling, which uses an electric field to induce a subtle change in the movement of atoms within a

top of one another, with only a thin gap of air between them. This small, ceramic stack sits inside a tube filled with fluid. When an electric field is applied, the phase transition happens within the solid ceramic material. causing it to heat up. The fluid dutifully absorbs heat from the stack and displaces it to one side of the

gets significantly coole (around 15 degrees Celsius). "Little by little, you radically different from the cooling technology people rely on today and could be around 20 perfor space cooling one day, Defay estimates. However

create this gradient of tem-perature," he adds. It is cent more efficient overall

The cooling dilemma amid climate change

Are air conditioners the solution to heat, or the cause?

Contd from page 19 explained below

Energy-intensive cooling mechanism: Unfortunately, although efficiency (defined as the amount of energy necessary to cool a room) has improved over the last decades, inefficient equipment dominates the market for air conditioners mainly as 37 per cent today to over 45 per cent by 2030 putting further stress on already overwhelmed energy grids.

Two-pronged Problem of GHG Emissions: Air condi-tioners need electricity to function. The energy supply needed for artificial air-conditioning generates about 4 per cent of global greenhouse gases emissions, twice as

which specify the minimum level of energy performance that appliances and equipment must meet or exceed before they can be supplied or used. However, they are absent or not always mandatory in hot or humid countries with rapidly growing demand for air-conditioners

Overuse of Airconditioning: In high-income countries



material, a kind of phase transition, changing the material from one state to another. This causes a temperature change within that material.

Last November Emmanuel Defay at the University of Luxembourg and colleagues published a paper in which they described an electrocaloric cooling device. It's made using thin strips of ceramic material stacked on

tube. Then, the electric field is turned off and the stack cools down. As that happens, the fluid moves in the opposite direction, ultimatecooling the other end of the tube.

"They are somehow dancing together," says Defay. Over roughly 100 cycles, one end of the tube gets hotter (reaching around 30 degrees Celsius) while the other end

the laboratory prototype has only about 4 watts of cooling power, and the ceramics are made using less-than-ideal materials such as lead, which is toxic. Tušek notes that the long-term reliability of the materials used in such a system is yet to be proven.

In the race to develop better active cooling tech nologies, we might miss the – Chris Baraniuk



customers tend to prioritize low-cost over the life-cycle cost of equipment, and manufacturers focus on lowering production costs and increas ing sales volume. The typical air conditioner sold is less than half as efficient as the highest-performing product on the market. This is the case in every region of the world. This inefficiency strains the power grids, espe-cially on hot days when space cooling can account for over half of peak electricity demand. This can lead to power outages, resulting in a higher risk of heat-related illness and death due to a lack of indoor cooling and broken cold chains in the food and health sectors. Outages can also result in carbon monoxide poisoning, gastrointestinal illness, and sickness due to the failure of electricalpowered medical equipment.

According to the International Energy Agency (IEA), by 2050, the world will see a threefold increase in air conditioner-related energy demand, equivalent to adding 10 new units per second over the next three decades. This, combined with rising temperatures and living standards, is expected to raise global air nditioner ownership from

much as the entire aviation industry. In 2021, space cooling accounted for about one gigaton of CO2 emissions from the power sector, and the fine particulate matter (that is, PM2.5) pollution from fossil fuel combustion to power air-conditioners was responsible for 24,000

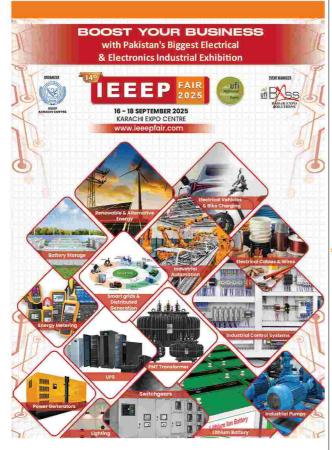
deaths globally in 2020. In addition, the hydrofluorocarbon (HFC) refrigerants used as coolants also escape into the atmosphere. The HFCs have high Global Warming Potential (GWP) and absorb 150 to 5,000 times more solar energy than CO2, contributing severely to global warming and creating a greater need for cooling. The 2016 Kigali Amendment to the Montreal Protocol, ratified by 155 countries as of early October 2023, mandates a reduction of the production and consumption of HFCs by more than 80% by 2047; however, mitigating GHG emissions from air-conditioners require cleaner energy producn as well as phasing out HFCs through adoption of alternative technologies in the cooling sector.

In major cooling markets today, there are requirements for air-conditioners to meet Minimum Energy Perform-ance Standards (MEPS)

like the United States where air-conditioner ownership is nearly 90 per cent, the behaviour around energy consumption is also a negative factor. Air conditioning is crucial during heatwaves, but its widespread and exces sive use in daily life contributes significantly to its climate impact. The overuse, often seen in high-income countries, hinders the ability to adapt to hot weather, mak ing us more vulnerable and dependent on air-conditioning. While more efficient technological solutions are emerging, behavioral adjustments are crucial to deal with cooling-related energy crunch.

Social Inequality and Heat Vulnerability: Despite deployment increasing glob-ally, in regions with scorching climates inhabiting about 3.5 billion people, the ownership of air-conditioners is merely 15 per cent as of 2021. The people most in need of space cooling are often those with the least access to solutions. For example, only around 5 per cent of households in sub-Saharan Africa are equipped with an air-conditioning unit. about 24 per cent in India,

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Pakistan's Cooling Needs Assessment

5th highest total cooling demand of any country, estimated at 646 billion Person Cooling Degree Days per annum, but access to cooling and the penetration of cooling appliances remain low.

Chilling Prospects: Tracking Sustainable Cooling for All (SEforAll, 2022) lists Pakistan among the 54 high-impact countries and the 9 critical countries with the greatest number of people at high risk from inadequate cool-

The country regularly

temperatures in the world, with an average of around 29°C during the summer months.

Furthermore, the Intergovernmental Panel on Climate Change (IPCC) projects a global average temperature increase of 3.7°C by 2081–2100, while a 5.3°C increase is projected for Pakistan under the highest emissions pathway scenario.

As temperatures rise in the country, cooling technologies will become increasingly critical for health and productiv-

The cooling demand, while growing, does not account for households without access to

nor the broader unmet cooling demand. In Pakistan, fans and

ly all households own an electric fan, but only 11% own an air air conditioners are used for

space cooling, and a variety of refrigerating appliances are used for food storage in the domestic

conditioner, which is still considered a luxury item by the majority of the population.

and pharmaceutical sector. Near

refrigerators, which are necessary for preserving food during the prolonged summer season wever, due to the limited use of cold chain technology, 40-70% of food is wasted at various stages of the supply

The current demand for cooling and refrigerating appliances has mostly been driven

 Rising temperatures and heatwaves. Most of Pakistan, especially the Punjab and Sindh provinces, experience long and hot summers with temperatures consistently exceeding 40°C. In 2022, Pakistan experienced an unprecedented heattures as high as 49°C and extreme heat affecting about a third of the country's land area.

 Increasing income levels. In 2022, Pakistan recorded a GDP growth rate of 5.97%, with GDP in real terms around USD 383 billion, placing the Pakistani economy at the 44th rank globally in terms of nominal GDP and 24th in terms of purchasing power parity.
According to The World in
2050, Pakistan could become the 20th largest economy by 2030, potentially rising to the 16th position by 2050.

Increasing population and urbanization. With over 230

Contd on page 30

The cooling dilemma amid climate change

Are air conditioners the solution to heat, or the cause?

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less than 20 per cent in Indonesia, and around 30 per cent in Mexico and Brazil This compares with more than 85 per cent in Japan. Korea, and the United States This leaves an estimated 2-4 billion people in the Global South, or 25-50 per cent of the world's population of the global population to the dan-gers of heat stress. In some European countries, particu-larly in the South where summer temperatures reach dangerous levels, the AC ownership is also comparatively low, though this has been rapidly changing.

Structural inequality in infrastructure and economic systems makes marginalized tion, the lack of green spaces and proximity to industrial operations make lower-incomdistricts hotter than other welloff neighbourhoods, pushing them further toward energy poverty.

Urban Heat Island Effect: Global warming impacts are felt most acutely in cities and they are heating up at twice the global average rate due to the urban heat island effect (when cities experience higher air temperatures than the surrounding countryside, due to energy from all the people, cars, buses, trains and build-ings). Air-conditioners expel heat from the indoor to the outdoor environment which increases outdoor tempera ture significantly in densely

above 35°C will increase by 800 per cent to reach 1.6 billion by mid-century

The escalating need for cooling drives up greenhous gas emissions, intensifying global warming and necessitating even greater cooling

Implications for children According to UNICEF's report on heatwayes, around 559 million children are exposed to high heatwave frequency, and around 624 million children are exposed to either high heatwave dura tion, severity, or extreme high temperatures.

The number of heatwave days children experience have increased. According to the 2022 report of the Lance

child on earth (over 2 billion children) is to face more frequent heatwaves, regardless of whether the world achieves a 'low greenhouse gas emission scenario' with an estimated 1.7 degrees of warming in 2050.

Extreme heat poses substantial threats to children's physical health, including an elevated risk of cardio vascular diseases, low birth weight, increased incidence of diarrhoea, heightened vulnerability to mosquitoborne diseases like dengue fever, greater susceptibility to chronic respiratory conditions, undernutrition, and the development of allergies, as well as the potential for heat stroke and hea

High temperatures are also linked to increases in mental health problems in children and adolescents, including post-traumatic stress disorder and depression, owing to their unique ways of interacting with their environment, limited adaptive capacity, depend-ence on stressed adults, and lifelong exposure.

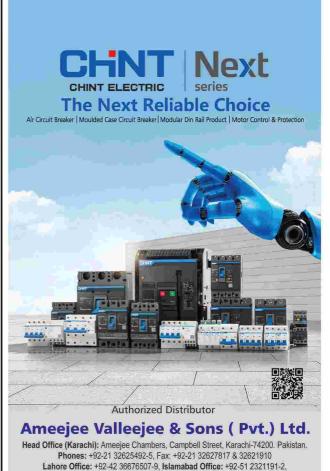
There are social and educational risks associated with children's unmitigated exposure to high heat. Extreme heat can worsen educational inequalities globally. Increased exposure to hot school days reduces the rate of learning and negatively affects long-term learning and students' academic performance. These adverse impacts are more pro-nounced among the lowincome and minority stu-dents. It affects children's economic prospects in the future. Keeping classrooms cool has demonstrated significant mitigation of the negative effects of heat on student achievement, highlighting the importance of cooling for children's wellbeing. - UNICEF



communities highly vulnerable to the extreme heat. Air conditioning is unavailable to households with no electricity and remains unaffordable due to high electricity bills holds with electricity. In addibuilt cities. The night-time temperatures can rise by more than 1° C, exacerbating the nocturnal heat island effect. If the current trends in urbanization and increasing heat continue, it is expected that the urban population exposed to a summertime temperature

ntdown, during the period 2012-2021, children younger than a year experienced 600 million more person-days of heatwaves (4.4 more days per child) annually compared with the average in 1986-2005.

By 2050, virtually every



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Pakistan's Cooling Needs Assessment

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the fifth most populous country in the world. Growing at an estimated rate of 2% annually, the population is projected to reach 245 million by 2025 and over 350 million by 2050. Currently, about 32.5% of the population lives in urban areas. The United Nations estimates that by 2050, nearly half of Pakistan's population will reside in cities

An expanded grid. The number of households with access to electricity has increased rapidly in recent years, reaching 74% in 2021.

Almost 22% of Pakistan's population lives below the poverty line. The two main barriers hinder ing access to cooling include the lack of a steady electricity supply and the affordability of cooling appliances and their operation. With 26% of the population not connected to the grid, affordable solar solutions and off-grid appli-ances will play a key role in bridg-

ing the cooling access gap.
In 2021, Pakistan's total electric power generation was about 143 TWh. According to analysis by CLASP and SAMA^Verte, cooling appliances consumed an estimated 46% of this total, accounting for 84% of the domestic sec tor's total electricity consumption and 78% of the commercial sector's. As more people are able to purchase cooli appliances, dramatic increases in energy demand on an already overburdened grid and associated greenhouse gas

emissions are expected. RATIONALE FOR A PAK-ISTAN COOLING ACTION PLAN

Pakistan currently lacks a national strategy to prioritize and coordinate activities in the cooling sector, as well as a mechanism to effectively identify cooling gaps. Given that the population is at high risk of heat-related incidents due to inadequate access to cooling, it is imperative to develop a plan that

- Manages current and
- future cooling demand,
 2. Reduces the gap in access to cooling, and
- Decreases emissions from the cooling sector.

The Government of Pakistan, with technical support from CLASP and SAMA^Verte (formerly known as HIMA^Verte), and financial support from the Clean Cooling Collaborative (CCC), is develop ing the country's first integrated cooling strategy: the Pakistan Cooling Action Plan (PCAP).

In line with Pakistan's revised 2021 Nationally Determined Contributions (NDCs) and other national climate goals, the PCAP will-

- · Establish a baseline for pri-
- ority cooling sectors,
 Identify paths for timely action, and
- · Outline concrete interventions to manage the growing cooling demand while reducing associated

The PCAP will be developed by the Ministry of Climate

Change (MoCC), in collaboration with the National Energy Efficiency and Conservation Authority (NEECA), other federal and provincial departments, and industry associations

This data-driven cooling eeds assessment was conducted to inform the PCAP. It examines the existing cooling landscape, identifies where cooling is most needed and used, and highlights areas of expected growth. The assessment focuses on:

· Domestic and commercial

COOLING NEEDS ASSESS-MENT - MAIN FINDINGS Policy Landscape

Pakistan's revised 2021 NDCs set an ambitious target to reduce 50% of projected emissions by 2030 (up from 20% in the 2016 submission). The NDCs call for the development of a Pakistan Cooling Action Plan (PCAP) and the implementation of refrigeration and air conditioning standards and labels to help meet emissions targets. However, no specific reduction targets



- · Domestic air conditioning, and
- · Electric comfort fans used for space cooling.

These sectors were prioritized by government stakeholders due to their high energy consumption and emissions. The assessment also includes a baseline for cooling access and provides a brief overview of the broader cold chain and servicing sectors. informed through stakeholder consultations. It focuses only on met cooling demand, due to the complexity and limited scope and resources of the project

for the cooling sector are includ-

NEECA's Strategic Plan 2020-2023 identifies the development of Minimum Energy Performance Standards (MEPS) and labeling for cooling appliances-including fans, air conditioners, and refrigeratorsexpected savings of up to 0.2 Mtoe by 2023.

Currently, MEPS and labeling policies for the following seven cooling appliances are at various stages of approval and pending nplementation

Electric fans: Mandatory MEPS and a 5-star labeling scheme for ceiling, table, pedestal, wall, and exhaust fans (expected in 2023).

- · Air conditioners: Mandatory MEPS and a 5-star labeling scheme for domestic units have been officially approved but not
- formally adopted.
 Refrigerators: MEPS and a 5-star labeling scheme for upright refrigerator-freezers have been finalized and approved but await adoption.
- · Visi-coolers: MEPS are under review by the Pakistan Standards & Quality Control Authority (PSQCA) and NEECA.
- · Horizontal beverage coolers. chest freezers, and refrigerator-freezers: MEPS were submitted in 2022 and are under review for approval.

COOLING DEMAND ASSESSMENT

This assessment sets a base-line for the following priority cooling appliance sectors:

- · Domestic space cooling, including air conditioners used in homes and small buildings. and electric fans. Space cooling in Pakistan has traditionally been dominated by ceiling fans and evaporative coolers. Over the past decade, the demand for air conditioners has increased, with a gradual shift to split-type units. Nevertheless, electric fans remain the most common cooling appliance in households.

 • Domestic refrigeration,
- including upright and horizontal refrigerators and refrigeratorfreezers used in homes and sometimes in small retail establishments.
- · Commercial refrigeration. including visi-coolers, display cabinets, and freezers used in retail outlets, restaurants, and

other commercial settings. As disposable incomes rise and consumers increasingly purchase processed food and beverages, this sector is becoming more significant.

· Off-grid cooling applinces, primarily Direct Current (DC) fans used in off-grid and weak-grid areas. The 18-inch DC pedestal fan is the most widely used, often powered directly by solar photovoltaic (PV) panels or integrated into solar home systems with battery storage.

These sectors were prioritized due to their integral role in meeting growing space cooling and refrigeration needs, and because they offer substantial short- to medium-term potential for emissions reduction. Table 1 (not shown here) provides estimates of existing appliance stock, current sales, and projected annual sales growth through 2030.

ASSESSMENT OF FUTURE COOLING NEEDS

To assess future cooling needs, several policy scenarios were modeled to project appliance stock, energy consumption, and associated emissions—both direct (from refrigerants) and indirect (from electricity use)for the priority cooling sectors. The modeling combined CLASP's Mepsy tool (The Appliance & Equipment Climate Impact Calculator) and SAMA^Verte's in-house model-

Four Scenarios for Energy Consumption and Indirect Emissions:

Business-as-Usual

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Pakistan's Cooling Needs Assessment

Contd from page 30 (BAU): Assumes no additional policies or interventions are implemented.

MEPS Scenario: Reflects market response to the implementation of currently pending or under-development Minimum Energy Performance

Standards.
3. U4E MEPS Scenario: Based on United for Efficiency model regulation guidelines, reflecting a higher-efficiency policy approach.

Best Available Technology (BAT): Models the impact of adopting the most energy-efficient technologies currently available worldwide Where global data were lacking, this scenario aligns with U4E's "High Ambition" assumptions from their Pakistan Country Savings Assessment.

Five Scenarios for Direct Emissions:

BAU Scenario: No policy action taken.

Reduced Refrigerant Charge Scenario: Models policy to reduce refrigerant volume in appliances.

Reduced Annual Leakage Scenario: Projects effects of policies aimed at minimizing annual refrigerant leak-

Reduced Service Venting Scenario: Considers policy to limit emissions during servicing of appliances

Reduced End-of-Life Losses Scenario: Accounts for emissions reductions from improved appliance disposal practices.

Accelerated Refrigerant Transition Scenario: Repre-sents a shift to low-GWP refrigerants, achieving the most sig-nificant projected reduction in direct emissions.

Key Findings:

· According to 2022 BAU projections, indirect emissions account for 86% of total emissions from priority cooling appliances, while direct emissions make un

· Among indirect emissions fans contribute the largest share at 54% while air conditioners are responsible for 93% of direct emissions

· From 2024 to 2030, under the BAU scenario, cumulative energy consumption is projected to reach 695.4 TWh, and cumulative CO2 emissions may rise to 326.8 Mt placing significant pressure on Pak-istan's already strained electricity grid and exacerbating climate change.

. The MEPS scenario can reduce cumulative energy consumption by 14.5 TWh and CO2 emissions by 6.8 Mt.

. The BAT scenario could deliver roughly seven times more impact than the MEPS scenario, with cum lative savings of 109.7 TWh and 51.6 Mt CO₂.

· Fans, domestic air conditioners, and refrigeration (both domestic and commercial) offer substan tial opportunities to reduce energy consumption and emissions by 2030. Since fans account for around 27% of national electricity consumption, they present the highest impact potential and should be prioritized.

· Without policy interventions

Pakistan's cumulative direct emissions could reach 38.4 Mt CO2e from 2025 to 2030. The combined implementation of the five direct emissions policies could reduce this

total by around 7.9 Mt CO2e.

• The accelerated refrigerant transition policy offers the largest

in coming years, straining the national electricity system, increasing costs for consumers, and accelerating greenhouse gas

This National Cooling Action Plan (NCAP) provides a roadmap to meet Pakistan's growing cooling



emissions reduction potential among the five scenarios, with a proje cumulative reduction of 4.4 Mt CO2e from 2025-2030. As air conditioners produce over 90% of direct emissions, mandating low-GWP refrigerants in their manufacturing should be

THE WAY FORWARD

Cooling is a development priority for Pakistan-critical to safeguarding health, ensuring productivity, protecting food and medicine, and maintaining overall eco-nomic stability. Yet, without strategic policy intervention, Pakistan's cooling demand will rise sharply

needs sustainably while aligning with its climate, energy efficiency, and development goals. The proosed actions are practical, targeted, and capable of delivering significant short- and long-term benefits across multiple sectors.

A cross-sectoral and coordinated approach will be essential to success. Collaboration among ministries, regulatory bodies, pri vate sector actors, and civil se will ensure policies are feasible, adequately resourced, and broadly supported. Equally important is the continued development of local technical capacity, data sys

tems, and institutional frameworks to implement, monitor, and enforce policies effectively

RECOMMENDATIONS To meet its cooling needs in an affordable, energy-efficient, and climate-friendly manner, Pakistan

should take the following steps: 1. Finalize and Enforce Minimum Energy Performance Stan-

dards (MEPS) Prioritize MEPS for high-impact appliances such as fans, refrigerators, and air conditioners.

· Regularly update MEPS in line with international best practices and local market dynamics.

· Ensure that enforcement mechanisms are strengthened to prevent the sale of non-compliant products.

2. Accelerate the Transition to Low-GWP Refrigerants

 Develop and implement regu-lations that mandate the use of climate-friendly refrigerants, espe-cially in air conditioning and commercial refrigeration sectors.

 Facilitate training programs for technicians on the safe handling of low-GWP refrigerants.

 Promote the Adoption of Best Available Technologies (BAT)

· Provide incentives such as tax exemptions, rebates, or low-interest financing for manufacturers and consumers to adopt BATcompliant products.

 Encourage public procurement of high-efficiency cooling equipment as a market signal.

4. Expand Access to Off-Grid

and Passive Cooling Solutions
• Scale up deployment of DC fans and solar-powered cooling appliances in off-grid and weakgrid areas.

· Promote building design improvements such as passive

cooling, better insulation, and reflective materials through updated building codes and urban planning guidelines.

5. Improve Data Collection and Monitoring

 Establish centralized systems to track appliance sales, refrigerant use, servicing practices, and energy consumption.

 Conduct regular market assessments to inform policy updates and identify emerging trends.

6. Build Capacity Across the

Cooling Supply Chain

• Invest in training programs for manufacturers, retailers, service technicians, and regulators.

· Promote curricula on sustainable cooling in engineering and technical education institu-

7 Alien with International Climate and Energy Efficiency Initiatives

· Leverage opportunities for climate finance and technical assistance through global programs such as the Kigali Amendment to the Montreal Protocol, the Clean Cooling Collaborative, and the United for Efficiency (U4E) initiative

CONCLUSION

Pakistan's path to sustainable cooling is both a necessity and an opportunity. By taking swift and coordinated action now, the country can protect vulnerable populations from extreme heat, lower electricity demand, reduce greenhouse gas emissions, and enhance energy security. The National Cooling Action Plan offers a comprehensive, evidence-based strategy to achieve these outcomes—supporting a more resilient, inclusive, and climate-smart future for all.



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