



U.S.-Pakistan Centers for Advanced Studies in Energy

Annual Report
Fiscal Year 2019

Cooperative Agreement
No: AID-391-A-15-00001





USPCAS-E Project

Securing Pakistan's energy future	3
Project Accomplishments	6
Component 1: Governance	8
Component 2: Curriculum	12
Component 3: Research	16
Component 4: Exchange	20
Component 5: Sustainability	26
Highlights and Success Stories	32

The views expressed in this document do not necessarily reflect the views of the U.S. Agency for International Development (USAID) or the United States Government.

Securing Pakistan's energy future

The United States Agency for International Development (USAID) funded the U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E) project for five years, and we are indebted to USAID for its support and vision. National University of Sciences and Technology (NUST) and University of Engineering and Technology (UET) Peshawar have developed plans to support and continue the center's operation going forward. The centers now have about 45 faculty, and more than 1000 MS and Ph.D. students enrolled in energy-related areas, from renewables to thermal to solar energy.

U.S. President John F. Kennedy formed USAID in 1962. He believed in the power of science, engineering and education to transform nations. He said, "The human mind is our fundamental resource."

Pakistan's population has doubled since 1990. This explosive growth has stretched the capability of its systems, including energy, to adequately support a thriving economy. But Pakistan's hope lies in its people, particularly its young people, as a source of ideas, enthusiasm and innovation to remake Pakistan's infrastructure.

Growing up, energy crises were a fact of life for USPCAS-E scholar Amir Nangyal. Power outages of up to 18 hours in the heat of summer were commonplace. He knew that he wanted to change the situation for himself and his country. He joined USPCAS-E at UET Peshawar, and during his first semester, he learned how to design a solar energy system and then installed one in his home.

"I decided to be an engineer and find a solution to this problem. Alhamdulillah, for the last three years, I haven't faced load shedding because I installed a solar system in my house."

Amir explains that Pakistan lacks expertise and access to technology in almost every field. And the energy sector is no exception. "My wish is to teach everyone about designing their own system and doing their own power load management"

Amir's outlook is like that of other USPCAS-E scholars. They recognize the challenge and want to be part of the solution. We have planted seeds that we won't see grow, but we know that they will. The impact of the USPCAS-E project goes far beyond our original goals, and the centers will continue to work on research that addresses Pakistan's energy needs.

Projects like this one exist to boost a region or a country's progress in a critical economic area. In the case of USPCAS-E, that area is energy. Energy is ubiquitous, an invisible resource. But with even a brief power outage, activity grinds to a halt. When these disruptions are pervasive, the results can be devastating to economic well-being. Finding indigenous solutions is the key to creating relevant, affordable options that can be implemented across Pakistan.

In the final year of the USPCAS-E project, we met many critical milestones in the project's key component areas: governance, curriculum, research, exchange and sustainability.

A primary focus of our efforts has been on the financial sustainability of the centers. Why is this important? We have invested heavily in creating new knowledge and a trained workforce. The centers have developed 13 new degree programs and more than 150 graduate-level courses in cutting-edge energy fields. More than 1000 students have enrolled in these programs, and more than 300 have earned degrees to date, and we expect that number to grow to 400 by December 2019 – and to keep growing. More than 200 faculty and students have completed exchange programs. These opportunities for research training and cultural exchange have been transformational and will likely pay dividends for years to come. The center buildings at NUST and UET Peshawar provide 114,000 square feet of research and classroom space and include 16 state-of-the-art labs, two libraries and two Technology Centers.

GOVERNANCE

We hosted the fifth and sixth stakeholder meetings along with Think Tank Dialogues. These dialogues are critical to the sustainability of the centers as they assume the roles of connectors and thought leaders in Pakistan's energy landscape. Beginning in January 2019, the centers started organizing these meetings on their own, a critical handoff in the project, and one of many that happened throughout the year.

USPCAS-E hosted a joint international conference in March 2019 with UET Peshawar and NUST taking the lead. More than 550 attendees met for two days to discuss pressing issues and opportunities in renewable energy. Conferences help create vital connections within the partner universities, and they solidify a global network of partners. They also bring important research



findings to the center faculty and students so that they can stay abreast of the advancements in energy research.

On the heels of the conference, USPCAS-E hosted a multi-day leadership training for faculty and staff at both centers. These hands-on sessions led by ASU Professor Dan Shunk provided a critical opportunity for center leaders to work together to create meaningful and actionable strategic plans that will help carry the centers forward after the funded project. Everything that we have done up this point is to build the new leaders that can take Pakistan into a bright future. This training was designed to solidify all that the center leaders have learned during the past four years as they create their independent road maps for the future.

CURRICULUM

Curriculum requires ongoing review to adjust to changing industry needs and student expectations. In the past year, ASU conducted detailed curriculum reviews for all program streams at both NUST and UET Peshawar.

Pedagogy training provided USPCAS-E faculty with the latest tools to create the best possible learning environments for our students. ASU supported both partner universities in adopting the latest pedagogical practices to improve course delivery practices and enhance the learning experience. The six-month effort included classroom observations, a three-day pedagogy training, online modules and virtual Zoom sessions focusing on the scholarship of teaching and learning to provide actionable feedback to ensure that classroom instruction is on par with international best practices.

ASU worked with faculty at NUST and UET Peshawar to deepen their understanding of active learning approaches and improve their use of these approaches in the

classroom. In the wrap-up session held on June 27, 2019, participants shared their findings and classroom practices.

In the summer of 2019, ASU hosted a online program development training. Five visitors from Pakistan, visited the U.S. to learn more about online course content delivery for graduate courses.

RESEARCH

The USPCAS-E project supported and promoted a culture of applied research. Building on this research environment, NUST and UET Peshawar can attract the funding needed for the ongoing support of the centers.

The project provided funding for 36 applied and 12 joint (U.S.-Pakistan) research projects to address pressing energy problems in Pakistan. These research projects have fostered a culture of research and, most importantly, by creating directly applicable results that help communities and individuals flourish. Working together with Pakistan's Higher Education Commission, industry and government agencies, the centers can continue to identify solutions critical to grand challenges in energy. Together we can bring the unique strengths of academia to foster the development of research projects that will make an impact on Pakistan's energy landscape for the benefit of all.

EXCHANGE

We welcomed the last exchange cohort in January 2019. NUST and UET Peshawar sent 47 exchange scholars to spend the semester in top labs at ASU and OSU, bringing the total number of exchange scholars to 217. The exchange program was critical to jump-starting new ways of thinking about energy problems in Pakistan. The exchange program is one of the significant successes of this project, and

we have exceeded our project target of 200 exchange visitors—which was a revision to the original goal of 100!

Many of the exchange scholars have said that the opportunity to work in U.S. university labs and learn more about U.S. culture first-hand is transformational. We hope that these experiences will ripple across academic and cultural communities in Pakistan.

Many of you have been instrumental in supporting and mentoring the Pakistani faculty and students who visited the United States as part of the exchange program. We want to offer our heartfelt thanks to you all.

SUSTAINABILITY

Outside financial support helps leverage these accomplishments and creates a virtuous cycle. With funded research, training and testing services offered through their technology centers, both centers can sustain and continue these efforts. The centers have already reached their fund-raising targets of \$1 million each through public-private partnerships, and the new Technology Centers offer the opportunity to create multiple revenue streams.

The Technology Centers create a critical mass of high-tech capabilities that can be used by faculty and students for future research endeavors.

These Technology Centers also provide a source of income for the centers by offering unique photovoltaic training programs and testing services that address unmet needs in Pakistan.

The Technology Center training programs began in July 2019 and are designed to be immediately applicable, enabling students and professionals to put their new skills to work right away. Both Technology Centers are equipped with specialized state-of-the-art tools and equipment.

ASU also conducted a five-day train-the-trainer photovoltaic (PV) workshop in July 2019 for USPCAS-E faculty and staff as well as representatives of the solar PV industry. Led by ASU program manager, Bülent Bicer, each trainee learned to deliver training programs that provide vocational proficiency in the application, design, installation and operation of residential and commercial solar PV systems. They also learned how to conduct PV power plant surveys, identify potential material, safety and performance-related issues, and conduct analyses on the impact of these issues on long-term energy production for solar PV power plants in Pakistan.

Finally, the impact of the more than 300 graduates – with more to come – cannot be overstated. These men and women are poised to be catalysts for change in Pakistan's energy sector. Their training, drive, and dedication make them invaluable resources in the creation of a secure energy future for Pakistan. Thank you to

the many faculty, staff, stakeholders, and friends who helped make this project a success. We are indebted to you for your vision, dedication, and support.

Writing in the *Atlantic Monthly* in 1858, Oliver Wendell Holmes Sr. said a mind “stretched by a new idea or sensation ... never shrinks back to its former dimensions.” The USPCAS-E project has allowed many people to see the future from a new vantage point. After her exchange experience, USPCAS-E scholar Maria Kanwal altered her plans for the future. She applied for a scholarship and hopes to begin working on her Ph.D. in a U.S. or European graduate program in September of 2020. “Spending a semester working in the lab of Professor Zachary Holman was life-changing,” she asserts. “The experience was great for both my resume and my abilities. Working with Ph.D. students and post-docs in Professor Holman’s lab, I learned how research should be conducted, became more focused in my work, and improved my ability to approach problems in the lab.”

The stories of our scholars have a common thread: “I can do more and be more than I thought I could.” Their stories are stories of transformation and imbued with a sense of purpose about their futures and their hopes for Pakistan.

USPCAS-E graduate Muhammad Ahsan Amjed is from Rajana, a small town in central Punjab in district Toba Tek Singh. He is currently a Ph.D. student at Ocean University of China (OUC) in Qingdao, China, where he studies energy and environmental engineering. He says that many young scholars have benefitted from the USPCAS-E program and that these benefits extend beyond each individual to their families and communities, and Pakistan as a whole: “I would like to say thanks to USAID and USPCAS-E for supporting me at every stage and making this dream possible. It’s not just the story of one person; it’s the story of one family and one underprivileged small town. Most importantly, it enhanced the mutual relationship of two countries (USA and Pakistan) at a public level and helps Pakistan, from the grassroots level to higher government levels, to mitigate energy challenges.”

ASU is committed to connecting people around the world to education and research that improves the quality of life and economic well-being. We are proud of the accomplishments of the U.S.-Pakistan Centers for Advanced Studies in Energy, and we look forward to continuing this vital work around the globe.

Sayfe Kiaei, Ph.D.
Project Director/ASU, USPCAS-E

Energizing Pakistan

USPCAS-E Project Accomplishments

The USAID-funded U.S.-Pakistan Centers for Advanced Studies in Energy, USPCAS-E, created a partnership between Arizona State University (ASU) and two leading Pakistani universities: National University of Sciences and Technology (NUST) and University of Engineering and Technology Peshawar (UET Peshawar) along with partner Oregon State University (OSU).

PROJECT GOALS

BUILD NEW CENTERS OF ADVANCED STUDIES IN ENERGY

New buildings at the National University of Sciences and Technology (NUST) and the University of Engineering and Technology Peshawar (UET Peshawar) have created a catalyst for change in energy education in Pakistan. These modern facilities feature new labs and libraries plus the tools, environment and mindset needed for transformative change.



CURRICULUM

CREATE A MODERN, RELEVANT CURRICULUM

ASU supported NUST and UET Peshawar in developing new master's and Ph.D. programs and new courses. These new degree programs translate work in the classroom and lab into the public and private sector in a pragmatic and applied manner with a focus on immediate real-world applications.



RESEARCH

FOCUS ON HIGH-IMPACT APPLIED RESEARCH

The USPCAS-E project focused on energy research that directly relates to ongoing and future energy challenges that affect the lives of all Pakistanis and impede economic growth. These efforts include 36 applied research projects and 12 joint research projects with U.S.-based faculty at ASU and OSU.



EXCHANGE & SCHOLARSHIPS

FACILITATE LEARNING THROUGH EXCHANGE PROGRAMS

USPCAS-E supported the academic and research advancement of Pakistani students and faculty by hosting more than 200 exchange students and faculty at ASU and OSU to conduct cutting-edge energy research in state-of-the-art labs.



SUSTAINABILITY

ENSURE LONG-TERM SUSTAINABILITY OF THE CENTERS

USPCAS-E worked to ensure the sustainability of initiatives at NUST and UET Peshawar through fundraising strategies and the cultivation of public-private partnerships by raising more than \$2M in funding, creating new labs and two libraries, and securing internships.



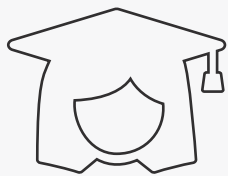
GOVERNANCE

FACILITATE INDUSTRY COLLABORATION AND STAKEHOLDER ENGAGEMENT

USPCAS-E is focused on the collaboration needed to develop world-class centers of energy engineering that will serve as Pakistan's go-to think tanks with the technical expertise to close the energy gap. As part of this effort, USPCAS-E worked to actively engage stakeholders throughout the life of the project.

13

New Master's & Ph.D. degree programs



375+

Graduates

1000+

M.S./Ph.D. students enrolled to date



150+

New Courses Offered

36

Applied Research Projects



9

Virtual seminars

12

Joint Research Projects with U.S. & Pakistani researchers

14

Technical workshops and visiting experts

217

Exchange Visitors



25%

female

555

Scholarships awarded



Entrepreneurial training



Cultural and academic excursions



Semester-long research experience



472

Stakeholders engaged

70+

Meetings to build engagement with the Public/private Energy Sector

121

Internships

\$2.2

Million raised in external funding



2

Technology Centers formed

21

Public-private partnerships





Governance

- ✓ 472 stakeholders representing all facets of the energy sector engaged via USPCAS-E stakeholder meetings
- ✓ Two Think Tank Dialogues held
- ✓ Supported three conferences
- ✓ Active engagement in governance forums (National Advisory Committee Steering Committee)
- ✓ Active engagement in research and curriculum committees at NUST and UET Peshawar
- ✓ Leadership training held to support effectiveness of the centers

During this reporting year, USPCAS-E worked closely with UET Peshawar and NUST on the following governance-related tasks and objectives: committee infrastructure; support of the project management unit; stakeholder engagement; leadership training; UET Peshawar management; and support for international conferences.

ENSURING THAT COMMITTEES ARE FUNCTIONING AND SUSTAINABLE

ASU provided technical insights, advice and recommendations to the National Advisory Committee, the Steering Committee and the Committee on Research Policy on matters pertaining to governance, research, curriculum and sustainability.

NUST's 6th Steering Committee meeting was held on November 16, 2018. Dr. Sayfe Kiaei and other ASU staff participated in the meeting and supported the formation of a Curriculum Advisory Committee with ASU. Dr. Kiaei emphasized the importance of starting an MS program in Energy Policy and Management during the life of project and advised NUST to consider an executive evening program focused on working professionals. Dr. Mahmood Butt (HEC) shared that they are in talks with ASU regarding involvement in the U.S.-Pakistan Knowledge Corridor, specifically sending Ph.D. students from Pakistan to ASU.

ASU assisted UET Peshawar in organizing a meeting with the Higher Education Commission (HEC) chairman on November 7, 2018, to obtain a No Objection Certificate (NOC) for the MS Energy Management and Sustainability degree program.

NUST held its 7th steering

committee meeting on August 22, 2019. The meeting was chaired by the Rector NUST and attended by USAID, industry representatives from Three Gorges Dams and Fauji Fertilizer Company Limited (FFCL), UET Peshawar, ASU and other members of the committee. ASU Project Director Dr. Sayfe Kiaei attended the meeting via Skype. The meeting approved the closure of the USPCAS-E project at NUST. The Rector thanked all partners and stakeholders for their support during the project implementation. He particularly acknowledged ASU for its technical support throughout the life of the USPCAS-E program. Dr. Kiaei thanked NUST for hosting ASU and for the support extended to ASU during the project.

UET Peshawar held its 4th steering committee meeting on September 17, 2019, in Peshawar, attended by Asima Rehman and Fazal Rabbi from USAID. Dr. Najeeb Ullah, Deputy Director USPCAS-E UET Peshawar, briefed the committee members about the project progress and shared challenges impeding targets such as the number of graduates and gender integration. Both AORs recognized the progress and achievements of USPCAS-E UET Peshawar despite the many challenges. ASU was recognized by USAID for supporting the center, particularly in research, curriculum development, governance structure and establishment of labs. During their visit to Peshawar, the AORs and representatives of Energy Office/USAID met with faculty and students, and toured the facilities available for research at the center including the labs and library.

STAKEHOLDER MEETINGS

5TH STAKEHOLDERS MEETING AND THINK TANK DIALOGUE: NOV. 2018

USPCAS-E organized their 5th National Stakeholders Meeting on Energy and second Think Tank Dialogue in Islamabad. The consultative session was attended by over 50 participants including senior officials from the Government of Pakistan, HEC, USAID, and industry and academic partners.

Led by Arizona State University, the session provided the centers with a forum to share updates on research laboratories and the ongoing applied energy research conducted by center faculty.

Forging a path to a sustainable future

The Think Tank Dialogue session provided a platform to discuss strategies for energy institutions both public and private, and universities to enhance cooperation and help address Pakistan's energy needs. Think Tank panelists included Dr. Tariq Banuri, Chairman HEC; Mr. Himayat Ullah Khan, Advisor Energy KP Government; Dr. Waqar Masood, Ex. Secretary Finance; and Mr. Hammad Hashmi, Advisor Ministry of Energy.

Moderated by Dr. Kiaei, the Think Tank dialogue focused

on the role of academia in energy policy development.

Speaking at the forum, Dr. Banuri, said that USPCAS-E centers can become sustainable through sponsored research, consultancy services, corporate investment, and philanthropic and public funds. Stakeholder engagement and feedback from all sectors—the energy industry, government agencies, NGOs and other funding agencies—is key to long-term viability and success.

The second panel discussion, moderated by Mr. Ammar Yasser, Corporate Engagement Specialist for USPCAS-E-ASU, focused on the impact and sustainability of the centers. They discussed issues such as the role of energy centers in international projects, the impact of international funding, the centers' role in advancing renewable energy in Pakistan, and building the capacity of the energy sector at the national level.

Showcasing graduate student research

The one-day meeting also featured over 30 student research posters that showcased some of the cutting-edge energy research being conducted by USPCAS-E faculty and their students at centers.

The visiting stakeholders provided technical feedback on the research projects that have the potential to be commercialized.

In her closing remarks, Ms. Asima Rehman, Senior Education Advisor USAID/Pakistan noted the accomplishments of the USPCAS-E program and particularly the linkages that have been developed among universities, industry partners and government agencies.

6TH STAKEHOLDERS MEETING AND THINK TANK DIALOGUE: SEPTEMBER 2019

Throughout the USPCAS-E project, Arizona State University kept its stakeholders engaged in driving private sector innovation, recommend policies for economic growth, and contribute solutions to address Pakistan's energy challenges. The stakeholder meetings provided regular opportunities to bring public and private sector experts together to foster dialogue and provide a forum for soliciting feedback and advice.

The 6th Stakeholders Meeting and 3rd Think Tank Dialogue was held in Islamabad, on September 24, 2019. Organized and led by ASU, this consultative meeting was attended by over 90 participants, including officials from the Government of Pakistan, HEC, USAID, and industry and academic partners. The meeting also provided a forum to share the USPCAS-E program achievements, particularly the applied energy research conducted by faculty and students.

A panel discussion focused on the impact of the USPCAS-E initiative on Pakistan's energy sector and future opportunities.

Panelists included Mr. Shahjahan Mirza (Managing Director Private Power infrastructure Board), Dr. Zain ul Abideen, (Director General HEC), Mr. N.A. Zuberi (COO Three Gorges Dam), Dr. Irfan Mufti, (Dean UET Peshawar), Mr. Ali Qureshi (National Expert, United Nations Industrial Development Organization), and Ms. Misbah Faiz, (USPCAS-E alumni and founder of Khawateen Rozgar Services). The panelist commented on the centers' achievements and emphasized the need for ongoing energy sector involvement in USPCAS-E to keep it relevant to the country's needs through mutually beneficial partnerships.

During the Think Tank Dialogue, a panel discussed the role of Pakistani universities in meeting the country's energy needs, producing a qualified workforce, and conducting industrial R&D. Experts included Dr. Rana Abdul Jabbar (Alternative Energy Development Board), Mr. Hammad Hashmi, CEO GENCO 2, Dr. Naveed Arshad, (Lahore University of Management Sciences Energy Institute), Dr. Fatima Khushnud (IPP Association), and Mr. Asim Ghaffar (Vice President LMKT). They discussed various approaches to bridge the gap between industry and academia, such as project-based internships, industry mentoring, joint research projects, training and capacity building, infrastructure sharing, and joint ventures.

The one-day meeting also featured over 15 research posters that showcasing research by USPCAS-E faculty and their students at both UET Peshawar and NUST. Key stakeholders provided technical feedback on the research projects and noted any commercialization potential.

ACADEMIC LEADERSHIP TRAINING

ASU hired Dr. Dan Shunk, an industrial engineering professor from ASU and a leading expert in process improvement and product development, to conduct a leadership training to enhance the skills of the senior and mid-level management of the partner universities so that the centers continue to carry out the vision and mission as envisioned by HEC and USAID.

The training, Leadership in Higher Education, was held in Islamabad March 18-21, 2019. The training was attended by 44 participants (six female) from NUST and UET Peshawar. The first two days were for all participants, followed by one day each for UET Peshawar staff and NUST staff to discuss their specific sustainability plans. These training sessions taught the participants leadership and strategic planning skills.

SUPPORT FOR EVENTS AT UET PESHAWAR

ASU assisted UET Peshawar in the organization of several events including:

A one-day book fair on April 4, 2019, to provide an opportunity for the faculty, staff and students to purchase relevant books for their research

and personal use at a discounted price.

The Youth Employment Expo 2019 on April 10, 2019, in conjunction with strategic partners including Khyber Pakhtunkhwa Information Technology Board (KPIT), Association of Chartered Certified Accountants (ACCA), Sustainable Energy Project (SEP) and Women in Renewable Energy (WIRE). Approximately 60 companies and 3,000 students participated in specially moderated sessions by energy champions from industry.

ASU assisted UET Peshawar with project inventory management. The inventory list was updated from October 2014 to May 2019. Recent purchases made after May 2019 are currently being updated. All inventory will be barcoded, branded and marked. Assisting UET Peshawar on an ongoing basis with its closeout work will continue October-November 2019.

ASU SUPPORT TO PROJECT MANAGEMENT UNIT AT UET PESHAWAR

ASU supported UET Peshawar in preparing a gender and graduate target modification letter for submission to USAID. The letter recommended the revision of graduate and gender targets informed by the latest enrollment, graduation and faculty data from the American Association of Engineering Education (ASEE).

ASU and UET Peshawar management held a meeting with the Speaker of the Khyber Pakhtunkhwa Assembly as well as Secretary Higher Education, Khyber Pakhtunkhwa to ensure support for the center's operations.

Additional support to UET Peshawar includes:

- Realigning the budget, including the correction of irregularities and updates to the UET Peshawar workplan for FY2019.
- Developing the project close-out plan.
- Developing the inventory list for final disposition including recently purchased IT equipment.
- Entering all the library books on the KOHA library software system.
- Developing a project review presentation for USAID and finalizing the presentation for the National Advisory Committee.
- Organizing USAID officials visit to Peshawar in September and then October.
- Developing plan for USPCAS-E closing ceremony.

SUPPORT FOR CONFERENCES

Organizing conferences raises the visibility of the centers and positions them as thought leaders and desirable partners in the energy arena in Pakistan. ASU supported its partners in hosting three conferences:



1. On October 1, 2018, the USPCAS-E NUST hosted the National Conference on Energy Trends.
2. The centers at NUST and UET Peshawar hosted a joint international conference in March 12-13, 2019.
3. ASU supported UET Peshawar in finalizing its National Conference agenda, arranged speakers for thematic areas and provided communications support to the UET Peshawar team to hold the National Conference on May 2, 2019.

NUST AND UET PESHAWAR DELEGATIONS VISIT ASU

NUST and UET Peshawar senior management visited ASU in the third and fourth quarters of FY19, respectively. NUST senior management was led by Rector Lt. Gen. Naweed Zaman (Retired), and the UET Peshawar team was led by Vice-Chancellor Dr. Iftikhar Hussain.

Both delegations met with senior management at ASU and discussed project related matters with a specific focus on future collaborations between the two institutions.

Discussions included:

- Bringing students from NUST to study and conduct research with faculty at ASU for 3-6 months, depending on the research project.
- Launching 3+1+1 programs in which students complete three years of an undergraduate degree at NUST or UET Peshawar, plus one year of undergraduate study and one year of a master's degree at ASU, thereby earning two degrees in five years.

A General Collaboration Agreement (GCA) was signed between ASU and NUST on September 21, 2019. The agreement will help in furthering

the relationship between the two institutions. The GCA with UET Peshawar is in process.

During his visit to Pakistan, Dr. Kiaei met with the Pro Rector for Academics at NUST and discussed project-related matters with a specific focus on collaboration between the two institutions post project closure. The decision was made to approach HEC to explore the option of funding NUST and UET Peshawar students at ASU for Ph.D. study under HEC's Knowledge Corridor initiative. The option of having NUST and UET Peshawar faculty visit ASU for 3-6 months was also discussed. It was decided that faculty will take the lead in contacting their counterpart faculty at ASU and work out details of these visits. NUST and UET Peshawar will cover the cost of the exchange.

CLOSEOUT PLAN

ASU submitted its detailed closeout plan to USAID for review and approval as per Cooperative Agreement requirements. A detailed list of furniture and equipment at the ASU offices at NUST and UET Peshawar was also compiled for submission to USAID. Once cleared by USAID, the list will go to NUST and UET Peshawar management for their information. As per USAID policy, all furniture and equipment will be transferred to NUST and UET Peshawar after project closeout.

The Cooperative Agreement for USPCAS-E NUST officially closed on September 4, 2019. ASU supported NUST in the review of their closeout plan and provided detailed feedback. The plan was revised and resubmitted to USAID. Officials from USAID Pakistan office visited NUST twice for discussion on the closeout plan, and the Deputy Director/ASU participated in these meetings to provide feedback and support to NUST to incorporate changes recommended by USAID.

Curriculum

- ✓ 13 degree programs developed
- ✓ 150+ new courses developed
- ✓ 1000+ MS/Ph.D. students enrolled
- ✓ 300+ students have graduated
- ✓ 16 new labs developed
- ✓ Pedagogy training program completed
- ✓ Technology Center training completed

CURRICULUM OVERVIEW

The annual curriculum review process of USPCAS-E NUST and UET Peshawar was initiated to review courses. The individual review plans for each stream at NUST and UET – Energy Systems Engineering (ESE), Thermal Energy Engineering (TEE), Electrical Engineering (EE) (Power), Renewable Energy Engineering (REE) and Energy Management (EM) – were developed by ASU in consultation with NUST and UET faculty.

ASU faculty reviewed the existing curriculum of the MS and Ph.D. in EE (Power) stream at NUST. The goal is to finalize the review recommendations for the consideration of the relevant approval forum at each university before incorporating the changes into the final curriculum.

ASU provided support to NUST in the development of MS Energy Policy and Management program. Initially the program was scheduled to start in fall 2021 but ASU suggested that it should start during the life of the USPCAS-E project, a suggestion supported by USAID. During the NUST Steering Committee meeting, ASU also proposed that it should be an executive program offered in the evenings to accommodate working professionals interested in pursuing credentials in policy and management.

The program was presented to the University Curriculum Review Committee (UCRC) on December 19, 2018, and conditionally approved beginning fall 2020. The approval is linked with the availability/hiring of faculty.

The Solar Thermal Power Plants course developed by Dr. Mariam Mahmood (NUST TEE faculty) was reviewed by Dr. Brian Fronk (OSU), Dr. Patrick Phelan (ASU) and Dr. A. M. Kannan (ASU).

The course was approved by UCRC. Upon approval at the Academic Council Meeting, the course was planned to be offered by NUST starting fall 2019.

HYDROPOWER PROGRAM

ASU supported USPCAS-E UET Peshawar in the finalization of the MS hydropower program. ASU led the curriculum development effort and engaged the stakeholders. ASU developed the complete MS hydropower curriculum in consultation with USPCAS-E and the UET Peshawar Civil Engineering Department. The ASU team regularly followed up with USPCAS-E management for the approval of the curriculum from Board of Studies and Academic Research (BOSAR) and lab funds from USAID.

THERMAL SYSTEM ENGINEERING PROGRAM

UET Peshawar shared the draft curriculum of the MS Thermal System Engineering program with ASU faculty for review. ASU faculty T. Agami Reddy, Patrick Phelan and Liping Wang conducted a detailed assessment of proposed courses for the new MS program and provided their feedback and suggestions to UET Peshawar. Dr. Kendra Sharp and Dr. Brian Fronk (OSU) reviewed the thermal lab equipment and software for UET Peshawar.

ENERGY POLICY DEGREE AT NUST AND UET PESHAWAR

The MS Energy Management Systems program is a successful program currently offered by UET Peshawar. This degree program attracts professionals from corporate and public sector organizations who seek to upgrade their qualifications and enhance their capacity in the area of energy management and policy.

NUST plans to launch an MS program in Energy Policy Management beginning fall 2020. The process is nearly complete, including program development, approval by NUST forums and faculty recruitment.

However, HEC's approval of the program is pending, and NUST anticipates completing the approval process by December 2019.

LAB EQUIPMENT

ASU faculty helped NUST to finalize the equipment for the proposed High Voltage Lab. The equipment and the lab plans were reviewed by ASU and detailed guidance provided to NUST. However, this lab was not approved by USAID.

ASU provided feedback on additional Thermal Lab equipment proposed by UET Thermal System Engineering department.

ASU also proposed that UET purchase a Thermal Power Plant Simulator and supported UET in identification of best available simulator. With this simulator, UET can offer specialized courses that have the potential to earn income and contribute to the sustainability of the center.

ONLINE PROGRAM DEVELOPMENT TRAINING

In the summer of 2019, ASU hosted five visitors from Pakistan, two from NUST and three from UET Peshawar, for online program development training. The main goal of the training was to help the centers to become knowledgeable about online course content delivery for graduate courses.

The learning objectives were to:

1. Gain knowledge on how to identify the appropriate Learning Management System (LMS).
2. Identify IT requirements for posting content online.
3. Identify best practices for preparing course content to be placed online.

The visitors met with ASU's EdPlus, Global Outreach and Extended Education (GOEE) in the Ira A. Fulton Schools of Engineering, and various ASU faculty.

Discussions included:

- Instructional design for an online environment
- Professional education online
- IT specifications for an LMS and media streaming
- Faculty recommendations on using an LMS to supplement courses

ASU also coordinated UET Peshawar's visit to Virtual University's Lahore campus where the team learned how to operationalize the online courses and online admission modules.

UET Peshawar installed an online video capturing system with the support of ASU in two classrooms. A detailed training was delivered to faculty for its effective use during lectures.

PEDAGOGY

A detailed needs assessment exercise was conducted by Dr. Peter Rillero (ASU) with all NUST and UET Peshawar faculty to get a better understanding of their pedagogy training needs. This exercise helped Dr. Rillero to develop a customized training program for the two centers.

Dr. Rillero conducted an initial three-day workshop for USPCAS-E faculty on Advancing Instructional Methods (AIM) January 15-17, 2019. A total of 33 participants (3 female) attended the workshop from NUST and UET Peshawar.

In addition, ASU also procured a license for Socrative software for each faculty member to help improve their pedagogical skills. Socrative is a cloud-based student response system that allows instructors to create simple quizzes to test student learning. These quizzes can be done quickly by students via their laptops, tablets or smartphones.

ASU also hired a consultant to conduct classroom observation of five selected USPCAS-E faculty to assess how the skills are being applied in the classroom.

The six-month effort included classroom observations, a three-day pedagogy training, online modules and virtual Zoom sessions focusing on the scholarship of teaching and learning to provide actionable feedback to ensure that classroom instruction is on par with international best practices.

ASU worked with faculty at NUST and UET Peshawar to deepen their understanding of active learning approaches and improve their use of these approaches in the classroom. In the wrap-up session held on June 27, 2019, participants shared their findings and classroom practices.

Nine faculty and staff from NUST and UET Peshawar completed all program components and received a certificate of completion: Abdul Kashif Janjua, Nadia Shahzad, Muhammad Noman, Affaq Qamar, Khurshid Ahmad, Muhammad Hassan, Fahad Ullah, Muhammad Shoaib and Kaleem Ullah.

See pages 38-39 to learn more.





A person wearing a white lab coat, safety goggles, and a white face mask is working on a piece of equipment. The equipment has a green frame and a white cylindrical component. The background is a light blue sky with some clouds.

Research

- ✓ 12 Joint research projects completed
- ✓ 36 Applied research projects completed
- ✓ 16 New labs created
- ✓ 131 Papers published to date
- ✓ 160 Conference presentations

QUARTER 1

A detailed review of all 12 joint research projects (JRP) was conducted by ASU's technical advisors. The primary goals were to review and close out cycle 1 projects and conduct a quarterly review of cycle 2 and 3 projects. These four JRPs were completed successfully during the first quarter:

- Development of Condition Monitoring Testbed — Dr. Govindasamy Tamizhmani (ASU) and Dr. Raza Kazmi (NUST)
- Hybrid Energy Testbed for Remote Communities — Dr. Brian Fronk (ASU/OSU) and Dr. Muhammad Zubair (NUST)
- National Energy Modeling Strategy for Pakistan and KP province — Dr. Clark Miller (ASU) and Dr. Irfan Mufti (UET)
- Hybrid Energy Testbed for Remote Communities: Integration of PV, Biomass Generator and Microhydro Generator — Dr. Brian Fronk (ASU/OSU) and Dr. Shoaib Khalid (UET)

The two JRPs with NUST were presented in Research Evaluation Committee (REC) meetings and the members asked for additional information before the closeout could be approved. The closeout reports were drafted and reviewed by ASU and shared with NUST and UET for verification of quarterly targets.

ASU also conducted a detailed quarterly review of six JRPs from cycles 2 and 3 at NUST and UET. Based on the review, the following JRPs requested and were granted no-cost extensions in quarter one:

- NUST — Dr. Arslan Khawaja/Dr. Bertan Bakkaloglu: no-cost extension until May 31, 2019
- NUST — Dr. Majid Ali/Dr. A. M. Kannan: no-cost extension until April 30, 2019
- NUST — Dr. Kafaitullah Ullah/Dr. Clark Miller: no-cost extension until April 30, 2019
- UET — Dr. Qari Khalid/Dr. Brian Fronk: no-cost extension until April 30, 2019

ASU participated in the 8th Council for Research Policy meeting held on November 29, 2018 at NUST. The committee approved the addition of student applied projects to the NUST Research Policy. ASU also participated in four REC meetings at NUST in this reporting quarter. In addition to local staff, ASU faculty also attended these meetings to provide feedback on the applied and joint research projects and other agenda items.

QUARTER 2

INTERNATIONAL CONFERENCE

USPCAS-E partner universities organized the International Conference on Sustainable Energy in Pakistan on March 12-13, 2019 at NUST. The conference brought together national and international energy professionals from the government, industry, academia and civil society to discuss the challenges and solutions related to energy generation, transmission, distribution and storage. The conference was inaugurated by the Federal Minister for Energy, Omar Ayub, and attended by over 500 participants. Eleven international speakers from the U.S., the UK, Denmark, Norway, South Africa, Sri Lanka and Malaysia delivered talks on four energy themes: renewable, thermal, electrical power and policy and management. In addition, 13 national energy experts participated in two panel discussions. The ASU team provided support to UET Peshawar and NUST in the arrangements including the formation of technical, administrative and communication committees, the identification of and coordinating with national and international speakers and finalizing the conference program.

RESEARCH PROJECT REVIEWS

ASU completed the final review of three first cycle joint research projects from NUST which include joint research projects (JRP) led by Dr. Clark Miller/Dr. Kafait Ullah, Dr. Govindasamy Tamizhmani/Dr. Ahmed Kazmi, and Dr. Brian Fronk/Dr. Muhammad Zubair. Dr. Miller/Dr. Kafait's project will be completed on April 30, 2019. Dr. Mani/Dr. Kazmi's project was closed by ASU. Dr. Fronk/Dr. Zubair's project is closed by both ASU and NUST and the closeout report was received for review and approval. Dr. Bertan Bakkaloglu/Dr. Khawaja Arsalan's project was reviewed

by ASU faculty. The following two JRPs at NUST were determined to be on track and will be completed on time:

1. Dr. Kannan/Dr. Majid's project completed key performance indicators (KPIs) for the second quarter and is scheduled to close in Q3.
2. Dr. Harvey Bryan/Dr. Bilal Sajid's project completed KPIs for the third quarter and on track for completion in Q3.

ASU participated in the 31st Research Evaluation Committee (REC) meeting held on February 1, 2019. At that meeting, Dr. Zubair and Dr. Brian Fronk's project was successfully closed. The meeting also reviewed applied research projects led by Dr. Muhammad Hassan and Dr. Khawaja Arsalan, and, on completion of KPIs, recommended the release of the next installment. ASU also participated in 32nd REC meeting held on March 26, 2019. The progress of four joint research projects was reviewed and upon successful completion of KPIs for the second quarter were approved their next installment. The four projects presented were Dr. Harvey Bryan/Dr. Bilal Sajid, Dr. Clark Miller/Dr. Kafait Ullah, Dr. Kannan/Dr. Majid Ali, and Dr. Bertan Bakkaloglu/Dr. Khawaja Arsalan. In addition to local ASU staff, Dr. Kannan and Dr. Bakkaloglu attended the meeting via Skype.

Similarly, ASU conducted the quarterly review of the joint research project at UET Peshawar being implemented by Dr. Mani/Dr. Saim Saher. The quarterly reviews show that this JRP to be on track and the quarterly KPIs have been completed. Technical feedback was provided to the principal investigators (PIs).

ASU continuously worked with the PIs of these JRPs awarded in cycle one for successful closure:

- National Energy Modeling Strategy for Pakistan and KP province (Dr. Irfan Mufti/Dr. Clark Miller)
- Hybrid Energy Test-Bed for Remote Communities – Integration of PV, Biomass Generator and Microhydro Generator (Dr. Govindasamy Tamizhmani/Dr. Muhammad Shoaib Khalid PI/Dr. Abdul Basit Co-PI)

The PIs have completed closeout reports and submitted these to ASU and UET Peshawar for review and approval. Based on the feedback, PIs are completing the required evidences and annexes for the closeout report. Two JRPs from UET Peshawar that were awarded in cycle one will be officially closed in Q3.

ASU provided support in reviewing the quarterly progress of 11 ongoing local applied research projects at UET Peshawar and advice in executing the research such as identifying the most appropriate location for the project "Data Communicator for Grid Control System (DCGCS). ASU also provided support in achieving the second-generation device development for grid monitoring.



QUARTER 3

NUST Joint Research Projects

ASU and USPCAS-E NUST officially closed Dr. Govindasamy Tamizhmani and Dr. Kazmi's joint research project at the REC meeting held on May 13, 2019. ASU officially closed the project in 2018, but NUST required more data and closed it in Q3. ASU also officially closed Dr. Harvey Bryan and Dr. Bilal Sajid's joint research project on green buildings on April 24, 2019, in a Skype meeting of the principal investigators and the evaluation teams from ASU and NUST.

As a part of the joint research project, Dr. Bilal Sajid visited ASU from April 15-19, 2019 to discuss and finalize the project report with Dr. Harvey Bryan. The visit also included field surveys and detailed discussions on replicating the project in other areas of Pakistan.

ASU also officially closed Dr. Kannan and Dr. Majid Ali's project on April 26, 2019. A Skype meeting of the principal investigators and reviewers from ASU and NUST was held to confirm that the project met all its objectives and KPIs as per the proposal submitted and approved by NUST and ASU. However, NUST had yet to close the project on its end. This project close was scheduled for next REC meeting in quarter four. Dr. Majid Ali was scheduled to visit ASU from June 24-28, 2019, for final discussions on the project and for replication and commercialization, however, due to a visa delay the trip was canceled.

ASU also officially closed Dr. Bertan Bakkaloglu and Dr. Khawaja Arsalan's joint research project on June 6, 2019. This project close was conducted during a Skype meeting of ASU and NUST principal investigators and reviewers. The reviewers confirmed that the project met its objectives and KPIs, and could officially closed.

However, NUST has yet to close the project. This project is expected to be closed at the next REC meeting.

Dr. Clark Miller and Dr. Kafaitullah's project on integrated energy modeling was delayed due to the departure of Dr. Dawarak Triplican from ASU. However, Dr. Miller and Dr. Kafait completed the KPIs and presented the project to ASU reviewers in quarter four to close.

UET Peshawar Joint Research Projects

The quarterly review of the joint research project "Transformer Predictive Maintenance" by Dr. Abdul Basit and Dr. Anamitra Pal was conducted on April 22, 2019. USPCAS-E UET Peshawar has received a phaser measurement unit from ASU and is in the process of testing at the local utility grid. Encouraging results are expected at the end of this research project; it was conducted with the provincial government of Khyber Pakhtunkhwa.

The quarterly review of the joint research project "Social and Hydrological Research to Improve Impact of Distributed Energy on Sustainable Development and Poverty Alleviation in Khyber Pakhtunkhwa" by Dr. Tanvir, Dr. Clark Miller and Dr. Kendra Sharp was conducted on April 28, 2019. The review confirmed that the project was on track, and the principal investigators are working aggressively to ensure the timely completion of the project.

The project "Hybrid Energy Test-Bed for Remote Communities – Integration of PV, Biomass Generator and Microhydro Generator," by Dr. Qari Khalid and Dr. Brian Fronk from Oregon State University (OSU) was extended until June 30, 2019. The extension was approved in the UET-P's Council of Research and Policy (CRP) meeting held on May 23, 2019.

Research Evaluation Committee Meetings

NUST held its 33rd Research Evaluation Committee (REC) meeting on May 13 to close Dr. Kazmi and Dr. Mani's joint research project; Dr. Sajjad Zaidi's applied research project; and Noor ul Ain Wasif and Hassan Pervaiz's student research projects. All projects were successfully closed. Dr. Kannan attended the meeting via Skype and local ASU staff attended the meeting in person for the evaluation.

Dr. Hussein Najmi's project's second quarter KPIs were approved for release of the next installment. The principal investigators of some closed applied research projects, Dr. Rabia Liaqat, Dr. Naseem Iqbal and Dr. Imran Mahmood, presented on the commercialization potential of their projects. However, these ideas have not been implemented yet and require further refinement. The meeting granted extensions to all existing applied and joint research projects until June 14, 2019.

ASU participated in the 34th REC meeting at NUST on June 14, 2019. The closure of Dr. Khawaja Arsalan's applied research project was officially approved by the committee. However, the meeting had some reservations about the closure of Dr. Taqi Cheema's applied research project because it had yet to complete its agreed upon KPIs.

The final decision on the project closure was expected to be confirmed in next REC. The closure of three student research projects of Ahmed Rasheed, Muhammad Kashif and Farooq Ahmed were approved by the forum. Initially, the plan was to discuss Dr. Kannan/Dr. Majid and Dr. Clark Miller/Dr. Kafait's joint research projects,

but due to the time difference between Pakistan and the United States a separate REC meeting was scheduled to discuss the remaining joint research projects at a mutually convenient time, planned for the first half of July 2019.

ASU facilitated and also participated in the UET Peshawar's CRP meeting held on May 23. The extension of two joint research projects and four applied research projects were approved by the Vice Chancellor of UET Peshawar.

QUARTER 4

Research Projects' Completion

A total of 12 joint research projects were awarded during project life. All projects completed their key performance indicators as agreed upon in the project contracts and were successfully closed.

Final reports for all joint research projects were completed and submitted by principal investigators, and reviewed by ASU's Technical Advisor and Research Lead. These reports will be signed off by ASU's Project Director as the approving authority.

ASU assisted in reviewing all 22 local applied research projects at UET Peshawar by identifying local experts as reviewers. All project reviews were completed during the reporting quarter and projects were successfully closed.

NUST also closed 15 student research projects. The students were awarded PKR 500,000 each for their respective projects.





Exchange

- ✓ 80 exchange scholars arrived in the U.S. in FY2019
- ✓ 217 exchange scholars have completed the program during the life of the project
- ✓ 3 technical workshops conducted in Pakistan this year (14 total)
- ✓ 2 virtual seminars conducted this year (9 total)
- ✓ 555 scholarships awarded during the life of the project

EXCHANGE PROGRAM

The goal of the USPCAS-E exchange program was to bring students and faculty to the U.S. to train them in state-of-the-art labs, provide hands-on research experience, and offer the opportunity to work with top faculty in energy-related engineering disciplines. The exchange experience can be a transformational one as visitors are immersed in high activity labs and surrounded by passionate researchers. Visiting scholars improve their communication skills, including writing, presentation skills and cross-cultural communication. They gain valuable international experience working with people from many different backgrounds and cultures.

Exchange scholars have many opportunities to share Pakistani culture with American students and faculty and act as ambassadors for their home universities.

During the FY2019, 80 scholars completed the USPCAS-E exchange program, 74 students and 6 faculty.

SUCCESSFUL COMPLETION INCLUDES:

- A minimum of 20 hours a week in their lab with a satisfactory prescribed course of training.
- Attending the 16-week training session in Energy Policy.
- Attending the 16-week training session in Technology Entrepreneurship. (ASU)
- Attending the energy engineering seminars series. (OSU)
- Cultural excursions like visits to the Grand Canyon, Universal Studios and

the Heard Museum for Native American Heritage Month. In these visits, they learned about:

- Environmental conservation and tourism.
- Native American tribes land conservation and utilization practices that promote tourism.
- National Parks as places that promote conservation and appreciation of natural resources while also contributing to the local economy.
- Gaining knowledge and practice of business etiquette, résumé building, interview skills and intercultural communication.
- Submitting the feedback survey.

SCHOLARSHIPS

Scholarships provide access to top educational experiences for promising students throughout Pakistan. USPCAS-E is working to provide increased educational access to women and disadvantaged youth.

555 scholarships were awarded including 50 given to other schools.

WORKSHOPS AND VIRTUAL SEMINARS

ASU conducted three workshops in FY2019:

1. Advancing Instructional Methods with Dr. Peter Rillero, an ASU professor. (January 15-17, 2019)
2. Leadership in Higher Education with Dr. Dan Shunk, an ASU professor and leadership researcher and consultant. (March 18-21, 2019)
3. Solar PV Workshop for Educators with Mr. Bülent Bicer, a project manager in the Ira A. Fulton Schools of Engineering at ASU. (July 8-12, 2019)

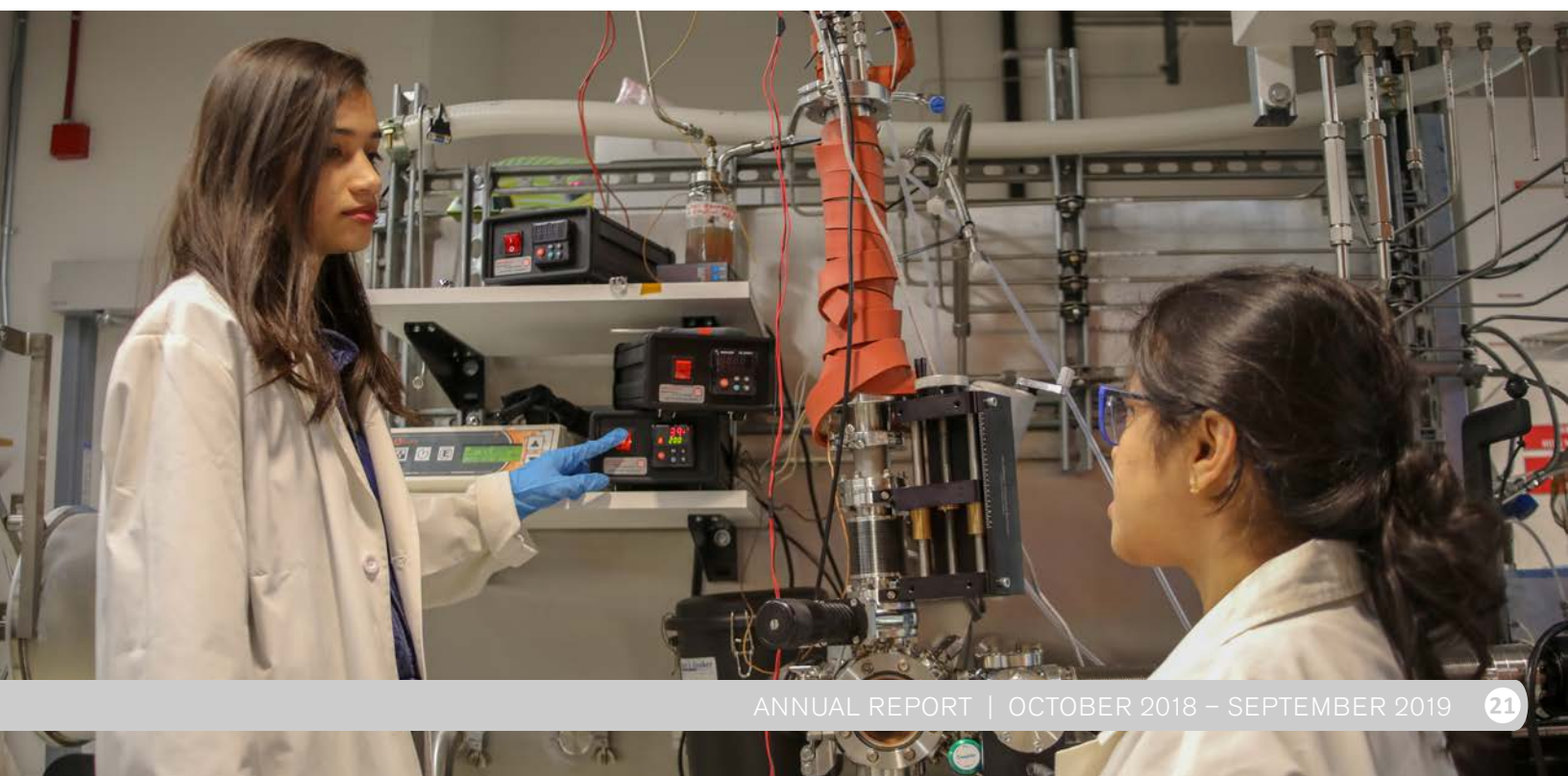
ASU delivered two virtual seminars in FY2019:

1. Entrepreneurial Mindset with Mr. Ken Mulligan, an entrepreneurship instructor from ASU. (December 2018)
2. Open-Source Hydropower Assessment Tool (HPAT) Package with Dr. Kendra Sharp, an OSU professor. (April 2018)

See pages 22-25 for more details.

USPCAS-E exchange scholars at ASU and OSU, 2016-2019

	STUDENTS		FACULTY		TOTAL	
	Male	Female	Male	Female	Male	Female
NUST	71	28	8	2	79	30
UET Peshawar	76	23	9	0	85	23
TOTAL	147	51	17	2	164	53
					217	



Virtual Seminars and Technical Workshops in Pakistan

Technical workshops from international expertise to faculty, staff, students and stakeholders in Pakistan.



DECEMBER 2018 – VIRTUAL SEMINAR

Technology Entrepreneurship

IMPROVING TECHNICAL INNOVATION THROUGH CERTAIN PATTERNS OF THINKING THAT UNLOCK THE ABILITY TO INNOVATE

The USPCAS-E program organized a virtual seminar on technology entrepreneurship for young engineers. Mr. Ken Mulligan, an ASU instructor who teaches entrepreneurship, provided an overview of entrepreneurial thinking patterns that consistently produce novel insights, breakthrough ideas and create value through high-value products and services.

This was an opportunity for Pakistani youth to learn from an entrepreneurial leader about various ways of

launching their own startups. Seminar attendee Abu Bakr commented that the talk was very inspirational. Ehsan Malik, an engineering student, remarked that the seminar was an eye opener for him because this was the first time he learned about the difference between a business setup and having an entrepreneurial mindset.

“Everyone of us should employ entrepreneurial thinking first, even if we aren't starting our own business!” he says.

Another participant, Asad Tariq, said that he learned about the qualities of entrepreneurs and the session also led him to think of ways to create opportunities for others.

“I want to shift from job seeking to job creation,” he remarked.

The USAID-funded USPCAS-E program is building capacity of its graduates and encouraging them to convert their research and innovation into startups that can provide solutions to Pakistan's energy needs.



JANUARY 2019

Pedagogy Workshop: Advancing Instructional Methods

USPCAS-E organized a professional development workshop for UET Peshawar and NUST faculty on active learning: Advancing Instructional Methods (AIM). Active learning is a process that involves students as active participants and partners in the learning process. About three-quarters of the 30 center faculty participated in the training to learn how they can improve classroom learning. Ten staff, including research associates and lab managers, also participated. The overall goal of AIM is to create a learning environment that promotes student learning and helps students excel as designers, problem-solvers, critical thinkers, team members and leaders.

This three-day workshop held January 15-17, 2019, was facilitated by Dr. Peter Rillero, an associate professor of science education at Arizona State University. This workshop was part of a comprehensive program designed specifically to improve teaching practices at the USPCAS-E centers and will lead to an Advancing Instructional Methods (AIM) certification.



MARCH 2019 – LEADERSHIP WORKSHOP

Building the next generation of leaders

ENSURING A BRIGHT FUTURE FOR THE USPCAS-E CENTERS

One of the focus areas of the USPCAS-E project is to ensure the sustainability of the centers after the life of the five-year USAID-funded project. The centers are expected to become think tanks for Pakistan's energy sector providing training, guidance and innovation for years to come. The success of this effort depends in large part on the people—faculty, staff, students and stakeholders—who will lead the ongoing efforts to find sustainable energy solutions for Pakistan.

To support these efforts, USPCAS-E hosted a multi-day leadership training in Islamabad for academic leaders at NUST and UET Peshawar in March 2019. This training was led by Professor Dan Shunk. A renowned leadership trainer with over 30 years of experience in leadership training, Shunk is the Avnet Chair and a professor of industrial engineering in the Ira A. Fulton Schools of Engineering at Arizona State University.

Professor Shunk's research and teaching expertise includes strategic innovation, new product development and strategic academic planning; strategic, top-down operational excellence; enterprise modeling and integration focusing on material flow/information flow/knowledge flow supply network integration.

This training was designed to help the centers at NUST and UET Peshawar develop the leadership skills, bandwidth and capacity to ensure the sustainability of the Centers for Advanced Studies in Energy beyond the life of the USAID-funded project.

TRAINING GOALS

- Provide an overview of modern leadership principles that will facilitate sustainable organizations and ventures.
- Assess the leadership and strategic capacity at the centers.
- Develop a 360-degree leadership assessment.
- Review and discuss the intrapersonal and interpersonal traits of good leadership.
- Demonstrate how leaders can make change happen.
- Establish an understanding of how organizations create a culture of innovation.
- Discuss strategic planning and implementation principles for sustaining start-up ventures.
- Develop center-level goals and implementation plans to achieve these goals.
- Discuss ways to obtain new funding streams once the USAID funding ends.
- Articulate how center contributions to the Pakistani energy sector create value.
- Create a sustainability strategic plan for each center.

The training provided attendees with a focused, hands-on opportunity to work together with their colleagues to draft strategic plans with the benefit of expert guidance from Dr. Shunk.



APRIL 2019 – VIRTUAL SEMINAR

Using technology to map hydropower

Arizona State University organized a hydropower virtual seminar on April 23, 2019, for USPCAS-E scholars at UET Peshawar and NUST. Facilitated by Professor Kendra Sharp from Oregon State University (OSU), the seminar covered the assessment needs for small hydropower systems and the tools developed at OSU to improve the assessment process, particularly in terms of seasonal and long-term power stability as well as expected impacts of climate change on power availability.

Sharp stressed the need for distributed energy systems in Pakistan because of the rural-urban divide in electricity access. The seminar highlighted the key parameters needed to calculate power potential for a hydropower system and sources of data for these parameters of estimating hydropower resources.

Sharp touched upon the role of snow and glaciers as a water source over an annual cycle, as well as expected impacts of climate change. She also discussed the process and presented results from the application of Hydropower Assessment Tool (HPAT) to a series of study sites from an OSU-ASU-UET joint research project to show the changes in water availability over an annual cycle at these sites.



Ayesha, a participant, mentioned that the session was useful for her to learn about hydropower potential in Pakistan and identify places where abundant water resources are available.

Majid Khan, a Ph.D. student, remarked that the talk was not only beneficial for beginners in this field, but also gave a bird's eye view of Pakistan's hydro potential from an international perspective.

The USAID-funded USPCAS-E program is building capacity of its graduates in renewable energy and promoting the application of clean and green energy to address Pakistan's energy needs.



JULY 2019 – WORKSHOP

Solar PV Workshop for Educators

Arizona State University conducted a five-day train-the-trainer workshop July 8-12, 2019. The workshop was held at NUST for faculty and representatives of the solar PV industry. Facilitated by Bülent Bicer, a project manager from ASU, each trainee learned to deliver training programs that provide vocational proficiency in the application, design, installation and operation of residential and commercial solar PV systems. They also learned how to conduct PV power plant surveys, how to identify potential material, safety and performance-related issues, and how to conduct analyses on the impact of these issues on long-term energy production for solar PV power plants in Pakistan.

The focus of this train-the-trainer workshop was to provide internationally accepted best practices and skills in the design, installation and operations of solar PV energy systems in Pakistan. Each trainee was provided with all training materials with the expectation to further disseminate the learned knowledge to professionals, technicians and students through short programs and courses.

Virtual Seminars and Workshops

Technical workshops and seminars led by international experts bring the latest techniques, tools and knowledge to faculty, staff, students and stakeholders in Pakistan.

During the life of the USPCAS-E project, ASU facilitated 14 workshops and nine virtual seminars in Pakistan.

TECHNICAL WORKSHOPS CONDUCTED IN PAKISTAN

Facilitator	Organization	Workshop Topic	Date
1. Sayfe Kiaei	ASU	Renewable Energy, PV System	October 26-28, 2015
2. Clark Miller	ASU	Energy Policy and Leadership	March 1-3, 2016
3. A.M. Kannan	ASU	Batteries and Fuel Cells – An experiential approach	August 1-3, 2016
4. Harvey Bryan	ASU	Green Building Workshop: U.S. and Pakistani Practices	December 13-14, 2016
5. Chad Haines	ASU	Awareness and Strategy Building for Gender Equity in Engineering	March 28-30, 2017
6. Govindasamy Tamizhmani	ASU	USPCAS-E Solar Photovoltaic Certification and Reliability Workshop	May 23-25, 2017
7. Ken Mulligan	ASU	Technology Entrepreneurship	September 27-29, 2017
8. Alan Paul	Giant Angstrom	Strategic Proposal Development Workshop	February 6-8, 2018
9. Zachary Holman	ASU	Energy Materials: Research Opportunities in Photovoltaics	February 7-9, 2018
10. Lou Farina	Windmill Ridge Ventures	Corporate Engagement	April 19-20, 2018
11. Kendra Sharp	OSU	Hydropower	September 24-26, 2018
12. Peter Rillero	ASU	AIM Training Workshop	January 15-17, 2019
13. Dan Shunk	ASU	Leadership Training Workshop	March 18-21, 2019
14. Bülent Bicer	ASU	Solar PV Workshop for Educators	July 8-12, 2019

VIRTUAL SEMINARS

Facilitator	Organization	Workshop Topic	Date
1. George Karady	ASU	Reduction of lightning caused outages of high voltage transmission lines	November 2016
2. A.M. Kannan	ASU	Hydrogen Economy: Problems and Prospects	February 2017
3. Brian Fronk	OSU	Introduction to High Temperature Solar Thermal Power Generation	May 2017
4. Zachary Holman	ASU	Where will solar go next?	September 2017
5. Govindasamy Tamizhmani	ASU	Solar Photovoltaics - Testing and Certifications	December 2017
6. Clark Miller	ASU	Social drivers, dynamics, and outcomes of energy innovation	March 2018
7. T.W. Lee	ASU	Technical Issues in Thermal Power Generation Systems	September 2018
8. Ken Mulligan	ASU	Developing an Entrepreneurial Mindset	December 2018
9. Kendra Sharp	OSU	Open-source Hydropower Assessment Tool (HPAT) Package	April 2019



Sustainability

- ✓ 10 local technical seminars by energy sector experts this year
- ✓ 65+ meetings with energy companies in Pakistan
- ✓ 121 internships secured in different energy sector organizations to date
- ✓ 9 industrial visits this year
- ✓ \$2.22M of research funding raised to date

ENSURING THE LONG-TERM SUSTAINABILITY OF THE CENTERS

The financial sustainability of the NUST and UET Peshawar centers was a central goal and a focus of many USPCAS-E activities in fiscal year 2019.

QUARTER 1

2nd Think Tank Dialogue

ASU organized the 2nd Think Tank Dialogue on November 14, 2018. It was facilitated by Dr. Sayfe Kiaei. It was attended by 94 officials and donors from industry, government, academia and civil society. The session included a panel discussion with experts including Dr. Tariq Banuri, Chairman HEC, Dr. Waqar Masood Khan, Ex. Secretary Finance, Mr. Himayat Ullah Khan, Advisor KP Government on Energy and Mr. Hammad Hashmi, Ex. Advisor on Energy. There was agreement that the Centers for Advanced Studies initiative is an innovative approach with the aim to address Pakistan's energy, water and food security challenges. Attendees asserted that the centers must develop their sustainability plans post-USAID funding by focusing on the areas: i.) Research (policy and applied); ii.) The relationship between HEC and universities, e.g., funding faculty salaries, etc.; iii.) Executive education/trainings; iv.) Consulting services; v.) Donations/support from alumni; vi.) The use of center facilities and services by the public and private sector; and vii.) Publications.

It was agreed that both NUST and UET Peshawar should submit these plans to HEC for input. ASU initiated work on developing a National Agenda for Energy Research.

5th National Stakeholders Meeting

ASU organizes national stakeholder meetings to engage public and private energy experts and solicit their feedback on the progress of the Centers. The 5th National Stakeholders Meeting was held on November 14, 2018, at NUST in Islamabad. The objective of this meeting was to align research and curriculum with the needs of energy sector, invite input on policy matters and involve stakeholders in the sustainability efforts of the centers at NUST and UET Peshawar.

The meeting was facilitated by Dr. Sayfe Kiaei and attended by 94 officials from federal and provincial institutions (Ministry of Water and Power, NTDC, Energy Departments); energy utilities (IESCO, KESCO, PESCO); energy industry (e.g., Three Gorges Dams, Attock Gen, Star Hydro); bilateral and multilateral donors (KfW, AfD, The World Bank); academia (UET Lahore); and civil society (e.g., PPAF, SRSP, AKRSP). Participants concluded that being good technically/academically is important, but equally important is knowing the on-the-ground realities in order to be able to be effective in one's profession. Therefore, the actual practice or application of research is the most pressing need in Pakistan.

Industrial Liaison and Partnerships

ASU continued to support its partners in industrial outreach by arranging the following meetings in the reporting quarter:

- November 12, 2018 - Visit of Peshawar Electric Supply Company (PESCO) staff to UET. PESCO showed a particular interest in the Power System Lab. Further discussions will be held between PESCO and UET to propose training services to PESCO.
- December 20, 2018 - ASU contacted IFC Edge Program for possible collaboration with NUST for an implementation of a building energy rating system.
- December 5, 2018 - Visit of UNESCO representative to NUST for collaboration in energy policy development.
- December 5, 2018 - Visit of Ashfaq Mahmood, Ex. Secretary Ministry of Water and Power, to UET Peshawar to develop proposals for joint research projects.
- October 17, 2018 - Meeting with Integration Gmbh. to support the development of a NUST and UET partnership in the area of hydropower training.

ASU also identified collaboration opportunities with Private Power Producers Association, National Productivity Association and WSSP for both NUST and UET. ASU supported UET in organizing working groups in the areas of solarization of public buildings and waste-to-energy projects (including the identification of and invitation to industry experts).

Three MoUs were signed by the centers

during the reporting quarter:

1. October 30, 2018 - MoU signed between NUST and Golder Pumps Private Limited on a joint research project.
2. December 14, 2018 - MoU signed between NUST and Pakistan Council of Renewable Energy Technologies (PCRET) for the sharing of research facilities, student internships and joint research projects.
3. December 18, 2018 - MoU signed between UET and PCRET whereby PCRET awarded PKR1.5 million to UET for a research project, and enabling UET renewable energy students to conduct their research theses at PCRET labs.

In addition, an MoU was finalized between Alternative Energy Development Board (AEDB) and NUST to be signed quarter two. ASU also initiated discussions with National Productivity Organization for a collaboration with UET Peshawar.

Industrial Visits

ASU continued to support its partners in meeting their targets for industrial visits. The purpose of these site visits is to expose scholars to real-world power project implementations and management techniques. The following visits were arranged during the reporting period:

- October 22, 2018 - Visit of UET Renewable Energy students to Ghazi Barotha Hydel Power Plant.
- October 25, 2018 - Visit of UET Energy Policy and Management students to Neelum-Jhelum Hydel Power Plant.

Seminars

ASU continued to support its partners in meeting their targets of organizing local seminars. Four seminars were held during the reporting period:

- October 31, 2018 - Seminar with the United States Educational Foundation in Pakistan on the Fulbright scholarship program and the GRE held at NUST.
- October 15, 2018 - Seminar with the United States Educational Foundation in Pakistan on the Fulbright scholarship program held at UET.
- December 5, 2018 - Seminar of United States Educational Foundation in Pakistan on the GRE held at UET.
- November 29, 2018 - The seminar Energy Planning in Restructured Competitive Power Market was delivered by Engr. Ziauddin, Ex. Chief (Energy) Planning Commission of Pakistan at UET.

ASU also facilitated visits with officials from nine U.S. universities to NUST for graduate recruitment in association with the United States Educational Foundation in Pakistan on October 2, 2018.

Fund Raising

ASU continued its support to partner universities in the identification of different funding opportunities. Progress during quarter one included:

- Negotiated the allocation of funds amounting PKR 400 million in the Annual Development Plan 2018-19 of FATA Secretariat for UET to undertake solarization projects in FATA.
- Supported NUST in the development of evaluation criteria of 4MW Solar Power Plant at NUST. This project can generate an inflow of \$4 million into NUST's power system.
- Arranged a United Nations Industrial Development Program (UNIDO) visit to UET to discuss a \$120,000 grant.
- Supported NUST faculty in finalizing a contract with industrial partner on Energy Efficient Brick Kilns for \$80,000.
- Funding opportunity for a \$31,000 research study identified and shared with NUST.
- Arranged meeting between UET and Heavy Electrical Complex to initiate a project proposal for Ignite research funding amounting PKR1.8 million.
- Identified a joint research funding opportunity with Water Energy and Food Nexus and shared it with NUST faculty. This opportunity has the potential to fund three Ph.D. students abroad.
- Negotiated an allocation of funds amounting PKR 40 million in the Annual Development Plan 2018-19 of the KP Higher Education Department for UET Peshawar.

QUARTER 2

Industrial liaison

ASU continued to support its partners in industrial outreach. ASU facilitated meetings and visits with various industries and government institutions for possible collaborations. In addition to these meetings and visits, ASU identified General Electric's Grenoble France Scholarship Program 2019 for USPCAS-E NUST students, and arranged interviews for two students.

INDUSTRIAL VISITS AND LOCAL SEMINARS

ASU continued to support its partners in arranging student visits to industrial facilities. In addition, ASU supported USPCAS-E UET Peshawar in finalizing its annual visit and seminar plan. Three industrial visits were organized during quarter two:

- USPCAS-E UET Peshawar student visit to National Cleaner Production Center.
- USPCAS-E UET Peshawar student visit to Attock Refinery Limited.
- USPCAS-E UET Peshawar student visit to High Voltage Lab.

ASU continued to support its partners in meeting their targets regarding local seminars. Four seminars were managed during quarter two:

- Seminar held on February 26, 2019: "Sharing Australian Experiences in Solar PV Technology" by SAARC Energy Center for USPCAS-E UET.
- Higher Education Commission Knowledge Caravan Seminar organized with ASU support on January 22 at USPCAS-E UET Peshawar to give students opportunities to study in the U.S.
- Ten U.S. universities visited USPCAS-E NUST on February 19, 2019, and provided information on graduate student recruitment.
- Mock GRE session held at USPCAS-E UET Peshawar on February 23, 2019, and GRE session held at NUST on March 28, 2019.

Career fair support

ASU supported USPCAS-E UET Peshawar in designing and conceptualizing a career fair including preparation of a list of industry invitations and an invitation package; a list of 70 energy sector employer organizations; and outreach to the energy sector for participation in the career fair.

USPCAS-E NUST was also provided support in outreach to energy sector employers for a career fair at NUST.

Fund raising

ASU continued its support to partner universities in the identification and access of different funding opportunities. ASU organized a meeting with United Nations Industrial Development Organization (UNIDO) and USPCAS-E UET Peshawar in which UNIDO expressed its willingness to allocate \$50,000 to USPCAS-E UET Peshawar and \$25,000 to UET Peshawar subject to the submission of proposals. ASU is working with USPCAS-E NUST and UET Peshawar faculty in developing funding proposals.

The ASU team also met the Advisor Energy for Khyber Pakhtunkhwa to ensure support to USPCAS-E UET Peshawar in collaborating on proposals for a) Microgrid Project totalling PKR 400 million; b) A waste-to-energy project totaling PKR 10 million; and c) a national conference.

ASU organized many meetings to explore funding opportunities and some major interactions are given below:

1. Meeting with Corporate Social Responsibility (CSR) Department of Oil and Gas Development Company Limited (OGDCL). They showed interest in funding joint projects in the area of solar energy in Pakistan.
2. China Pakistan Economic Corridor (CPEC) Working Group agreed to the allocation of funds for UET Peshawar in the area of device fabrication center; subsequent steps are yet to happen.

3. Outreach to KfW to align their Renewable Energy Institute with the USPCAS-E NUST Technology Center; their delegation has already visited NUST.
4. Meetings with KfW and MoCC for funding for USPCAS-E NUST regarding its solarization and to conduct an energy audit of the MoCC Building. MoCC will cover the cost of the audit.
5. USPCAS-E UET Peshawar developed a training calendar for revenue generation with ASU support during FY19. It was sent to the Pakistan Engineering Council for approval.
6. Identified a funding opportunity from SAARC Energy Centre and shared with partner centers.
7. A concept note was prepared for USPCAS-E UET Peshawar on the development of solarization of Kohat village pilot projects.
8. Meeting of electrical faculty from USPCAS-E with the management of the High Voltage Lab at National Transmission Dispatch Company (NTDC) regarding collaborative research and internship placement.

Partnerships

As a result of enormous efforts of ASU team, three collaborations are either completed or in the final stages. These partnerships include:

1. An MoU was signed between Fauji Fertilizer Company (FFC) Energy and USPCAS-E NUST.
2. Finalized the working paper on an Advance Metering Infrastructure (AMI) workshop for active collaboration between USPCAS-E and the power distribution sector of Pakistan.
3. An MoU draft was finalized between USPCAS-E UET Peshawar and Water and Sanitation Service Company Peshawar in the area of waste-to-energy.

Think Tank

Based on ASU's example, NUST hosted its First Think Tank Session in January 2019. The agenda for energy research in the future was discussed as part of the Think Tank.

QUARTER 3

Sustainability efforts were the key focus in this quarter including efforts in fund raising, industrial liaison contacts, industrial visits, seminars, the Technology Centers, Think Tank and internships.

Fund Raising

ASU Project Director Sayfe Kiaei met with the HEC Chairman Tariq Banuri. Dr. Kiaei was asked to support the development of Grand Challenges on Energy for future World Bank funding.

ASU reached out to all the energy centers in Pakistan and briefed them on the opportunity. In addition to the USPCAS-E centers, the list includes Energy Informatics Group (LUMS), Center for Energy Research Development (UET Lahore), Pakistan Council of Renewable Energy Technologies (MoST), Energy Research Center (COMSATS), Climate, Energy & Water Research Institute (PRAC), Punjab Bioenergy Institute (UAF). A comprehensive Skype meeting was conducted, and a questionnaire was prepared to assess the current status of energy research in Pakistan. Based on the feedback received, a draft report was prepared on Grand Energy Challenges for Research in Pakistan.

With the support of ASU, the following funding was secured:

USPCAS-E UET Peshawar secured PKR 40 million from Higher Education Department Khyber Pakhtunkhwa to research third generation solar cells.

USPCAS-E UET Peshawar faculty secured funding of PKR 12 million from HEC's Technology Development Fund.

ASU supported its partner universities in developing proposals and concepts to secure funding including:

- USPCAS-E UET Peshawar faculty will work with industrial partners from Balochistan on a UNIDO Energy Management System Proposal with a funding allocation of US\$25,000.
- USPCAS-E UET Peshawar faculty to develop a proposal for Khyber Pakhtunkhwa Energy Management System funding resulting in a funding allocation of US\$25,000.
- USPCAS-E NUST faculty secured funding from COMSTECH amounting PKR 350,000.
- USPCAS-E UET Peshawar faculty prepared and submitted three proposals for an Islamic Development Bank funding opportunity.
- Connected USPCAS-E UET Peshawar with Pakistan Green Building Council for a funding proposal.
- USPCAS-E UET prepared and submitted a proposal to Oil and Gas Development Company Limited to offer technical services regarding solarization.

Industrial Liaison

ASU continued to support its partners in industrial outreach. The following activities took place during the third quarter:

- Prepared a brief for the consultative workshop on alternative energy that USPCAS-E UET Peshawar intends to hold in collaboration with the Khyber Pakhtunkhwa government.
- Supported USPCAS-E UET Peshawar in the successful organization of a National Conference in which more than 100 energy industry representatives participated.
-

- Arranged a visit of the Planning Commission to USPCAS-E UET Peshawar.
- Arranged a meeting between Paidar Tawanai and UET Peshawar to enter the Renewable Energy (RE) Competition.
- Supported a successful Career Fair on April 10 at USPCAS-E UET Peshawar. More than 60 companies participated, and a session was moderated by the ASU Corporate Engagement Specialist on the Energy Sector of Pakistan. ASU's Deputy Director for NUST also initiated a discussion to hold a similar career fair for NUST and met with the Project Director at NUST. Possible support from ASU for this career fair was also discussed.
- Arranged an invitation for the centers to the stakeholder meeting on "Promoting Energy Efficiency and Conservation for Sustainable and Greener Pakistan" with UNIDO held on April 15, 2019.

QUARTER 4

Technology Centers

ASU provided extensive support to NUST and UET Peshawar in the establishment of their Technology Centers. Mr. Bülent Bicer (ASU) visited Pakistan from July 8-12, 2019, to conduct a Solar Photovoltaic (PV) Workshop for Educators. This was a train-the-trainer workshop for NUST, UET Peshawar and participants of other technical institutions in Pakistan. Mr. Bicer trained 25 participants, including three government and industry representatives.

The training provided theoretical and hands-on-training to the participants on equipment purchased by the centers. Mr. Bicer was supported by Dr. Hasan Abdullah Khalid and Mr. Mudassir Ayub, who previously attended a three-week training at Dr. Govindasamy Tamizhmani's Photovoltaic Reliability Lab at ASU. The participants were awarded certificates on successful completion of the training.

ASU engaged Solar PTL in the United States to develop accreditation manuals for the Technology Centers. The manuals were shared with NUST and UET Peshawar for their review. NUST has provided their feedback for the finalization of the manuals. Solar PTL plans a three-day online training on accreditation for the staff of the Technology Centers. The centers will receive accreditation by an international organization after fulfilling all requirements.

6th National Stakeholders Meeting

The 6th National Stakeholders Meeting and Think Tank Dialogue was organized on September 24, 2019, at NUST in Islamabad. The objectives of the stakeholder meetings were to align research and curriculum with the needs of the energy sector, solicit input on policy matters, and

involve stakeholders in the sustainability efforts of the centers. A total of 93 stakeholders (13 female) attended meeting. Attendees included federal and provincial institutions, energy utilities, energy industry, bilateral and multilateral donors, academia and civil society. Attendees cited the need for applied research that balances technical and academic achievement with knowledge of the on-the-ground needs and realities of energy-related professions. ASU recommended that its partners continue to engage stakeholders beyond the life of the project.

Think Tank

ASU participated in a consultative workshop on Pakistan's Renewable Energy Policy, and supported UET Peshawar's partnership with an Energy Think Tank group during the quarter. As a result,

- UET Peshawar arranged a policy dialogue in collaboration with ASU and World Wind Energy Association on July 16, 2019.
- UET Peshawar arranged a Think Tank meeting in collaboration with ASU and Asia Foundation on September 16, 2019.
- USPCAS-E provided feedback to the relevant government forum on a draft Renewable Energy Policy.

Fund Raising

In his previous visit to Pakistan, ASU Project Director Sayfe Kiaei met with HEC Chairman Tariq Banuri. At that meeting, Dr. Banuri requested ASU's support for the development of Energy Grand Challenges for upcoming World Bank funding.

Follow-up meetings with HEC counterparts and energy center representatives were held to update them on the USPCAS-E program and gather insights on upcoming funding opportunities.

ASU arranged a meeting on September 25, 2019 to discuss the National Energy Research Agenda; officials from nine national centers attended the meeting. An HEC representative presented details on the funding opportunities available under the World Bank project that can help to ensure sustainable research funding for the centers.

With the support of ASU, UET Peshawar has partnered with private sector organizations on different World Bank funding opportunities related to energy efficiency. ASU assisted the center in securing \$75,000 USD from UNIDO for the Energy Management System program.

Industrial Liaison

ASU continued to support its partners in industrial outreach. The following partnership opportunities were identified during quarter four:

- Met with Al-Moiz Group for research collaboration with USPCAS-E UET Peshawar.



- Met with UN Habitat for collaboration with USPCAS-E NUST faculty in the area of building energy efficiency.
- Supported USPCAS-E NUST in engaging industry/ financial sector for biomass workshop with financial support from UNIDO.
- USPCAS-E to become part of the Energy Training Institute being envisioned by Independent Power Producers Association of Pakistan so that USPCAS-E can handle training component under the institute.
- The Association of Energy Engineers, Pakistan Chapter, plans to open a regional chapter at USPCAS-E UET Peshawar.
- Met with Karandaaz for possible collaboration on the upcoming Energy Efficiency and Renewable Energy Project.
- Energy Efficiency and Solarization Energy Audit of the Ministry of Climate Change completed and report submitted by NUST faculty with ASU support. The Ministry of Climate Change wants to partner with USPCAS-E regarding future funding opportunities.

Industrial Visits

ASU continued to support its partners in meeting their targets regarding student visits to industrial facilities. The following visits were managed during the reporting period:

- Supported visit of USPCAS-E UET Peshawar scholars to Tarbela Dam/Power Station on July 2.
- Arranged Industrial visit of USPCAS-E UET Peshawar scholars on July 11 to Coronet Food Industry Haripur.
- Arranged industrial visit of USPCAS-E UET Peshawar scholars to Sheikh Muhammadi Grid on July 18 and 27.
- Supported USPCAS-E UET Peshawar in arranging an industrial visit to a microhydro power project site in Kalam on September 5.

Seminars

ASU supported UET Peshawar in organizing local seminars including:

- A seminar on Waste-to-Energy Challenges and Opportunities was conducted at UET Peshawar on July 3, 2019. ASU support included identification of the speaker and coordination with the company. A total of 60 students and faculty participated. Peshawar Waste Management Company facilitated the seminar.
- A seminar by the U.S. Educational Foundation in Pakistan was conducted at NUST on September 25, 2019. ASU support included coordination with USEFP officials and scheduling the seminar at USPCAS-E NUST.

Internships

ASU interacted with public and private institutions to explore options and secure internships for NUST and UET Peshawar scholars. As of September 2019, the partner universities secured a total of 121 internships (71 for NUST and 50 for UET Peshawar), including 73 internships (35 for NUST and 38 for UET Peshawar) obtained through ASU support.

The main employers for internships included Water and Power Development Authority, Khyber Pakhtunkhwa Oil and Gas Company Limited, Attock Gen Limited, Pakistan Council of Renewable Energy Technologies and Planning Commission of Pakistan.

In this quarter, ASU arranged seven project-based internships at the Alternative Energy Development Board for USPCAS-E NUST students.

A meeting was held with the Chairman of the National Electric Power Regulatory Authority to arrange project-based internships for USPCAS-E NUST students.



USPCAS-E

Project News and

Highlights







OCTOBER 2018

NUST hosts national conference on energy trends

PAKISTAN NEEDS TO TAP LOCAL RESOURCES FOR LONG-TERM SOLUTION TO ENERGY CRISIS

On October 1, 2018, the USAID-funded U.S.-Pakistan Centers for Advanced Studies in Energy NUST hosted a National Conference on Energy Trends to discuss multiple energy sources. Experts from academia, industry, corporate sector and think tanks participated in this one-day national conference to exchange information and ideas on select renewables, thermal power generation, electrical power system engineering and planning, and energy policy.

The conference provided a platform to over 200 engineers and experts in the field of energy to review the latest national and CPEC-related developments, opportunities and challenges in

renewable and non-renewable energy sectors, and discuss and debate future trends.

In his message announced by the Joint Secretary Power Division Usman Akhtar Bajwa, the Federal Minister for Energy Omar Ayub Khan said NUST is recognized as a symbol of quality education and excellence in the field of science and technology. The increasing energy demand across the globe indicates that it will be the major issue in the future, and preparations must be made to lessen its impacts on the region, he added.

Speaking at the conference, Major General Muhammad Shahid (R) restated his commitment to making NUST one of the top universities in the world and a research platform to boost a knowledge-based economy in Pakistan. He expressed appreciation for U.S. support to build the Centers for Advanced Studies in Energy as the centers not only contribute to formulating sound energy policies for Pakistan; they also provide highly educated scientists and energy experts, particularly in renewable and power systems engineering and planning.



MARCH 2019

First international conference puts USPCAS-E centers on the energy map

"You're not going to solve Pakistan's energy crisis from Britain or the U.S. or any other place in the world," said Arizona State University professor Dr. Clark Miller in a Pakistani television interview in 2016. "You're going to have to own it and solve it here."

Three years later, and on the heels of the first-ever International Conference on Sustainable Energy in Pakistan (ICSEP), it's evident that Pakistani faculty, students and government representatives are doing just that.

The conference, held March 12 and 13, 2019, at the National University of Sciences and Technology (NUST) in Islamabad, was organized and hosted by the U.S.-Pakistan Centers for Advanced Studies in Energy project's three partners: ASU, UET Peshawar and NUST. The conference was a groundbreaking event featuring 11 international speakers and more than 550 participants, 120 of whom were Pakistani women pursuing technical careers in the energy sector.

"I see this conference as a valuable addition to Pakistan's now flourishing energy sector. Specialized research centers like USPCAS-E surely will play an instrumental part in providing sustainable and renewable energy solutions for Pakistan's energy challenges," said Mr. Omar Ayub Khan, Federal Minister for Power Division, in his address as the conference's chief guest.

Sustainable research centers, which produce sustainable energy solutions for Pakistan, are critical. And that's why this international conference was so monumental. It's a critical step in ensuring the long-term sustainability of the two USPCAS-E research centers in Pakistan, which were created as part of a collaborative five-year project with an \$18 million investment from the United States Agency for International Development (USAID).

Mr. Jerry Bisson, USAID Mission Director, said: "One of the most important investments we can make moving forward is in the institutions that foster innovation and the great minds that convene within them."

USPCAS-E was established with a driving mission to cultivate and grow indigenous talent in Pakistan specially trained to tackle the country's mounting energy challenges. The project's main goals are to focus on applied research relevant to Pakistan's energy needs and help produce skilled graduates in the energy field.

BUILDING ON ACCOMPLISHMENTS

Since the project's inception in 2014, USPCAS-E has, among other accomplishments:

- Built two new buildings, housing 16 labs and two libraries, at NUST and UET Peshawar.
- Developed 14 new degree programs at NUST and UET Peshawar.
- Initiated 48 joint and applied research projects.
- Established nine public-private partnerships.
- Graduated hundreds of Pakistani students with energy-related master's degrees.

USPCAS-E leadership and faculty decided to build on these accomplishments by hosting ICSEP, which fit perfectly into the overarching goals of the project in many ways.

"ICSEP provided a forum to highlight and disseminate the centers' achievements in applied research to the industry, academia, government and civil society," said ASU USPCAS-E Deputy Director Ahmad Saeed, based at NUST.

"Our stakeholders were able to get a better understanding of the high caliber of the faculty and graduates of the two centers. The conference also provided an opportunity to the faculty and students to network and learn from the experiences of the prominent international and national energy experts who attended."

Conference speakers were selected for their cutting-edge research and application in key areas, including:

- **Energy policy and management.** Highlights in this area included a presentation by USPCAS-E Project Director and ASU professor Sayfe Kiaei, on future trends in energy. Another notable speaker

was Dr. Adil Najam from Boston University, who presented the idea of distributed generation in a whole new manner and highlighted how a challenge can be converted into an opportunity.

- **Renewable energy.** Dr. Jawwad Darr of University College London-UK gave a keynote on new approaches and capabilities for energy storage materials, as well as an update on the UK Faraday challenge for energy storage. Another keynote was given by Dr. Kamaruzzaman Sopian of Universiti Kebangsaan in Malaysia, who focused on advances in photovoltaic thermal solar collectors.
- **Thermal energy engineering.** Technologies, barriers and research in the area of advanced biofuels via biomass gasification were discussed by keynote speaker Dr. Edd A. Blekkan, a professor at Norwegian University of Science and Technology (NTNU) in Norway.

STUDENTS SHINE IN RESEARCH POSTER SESSION

In addition to the plenary talks, technical sessions and panel discussions that happened throughout the two-day conference, faculty and students at USPCAS-E were able to showcase and discuss their work with visiting experts and local stakeholders. Pakistani students — 21 from UET Peshawar and 21 from NUST — presented research posters.

"In the poster session, the students had an opportunity for local industry and fellow researchers to critically assess the work they presented on their posters," said Dr. Tanvir Ahmad, a UET Peshawar professor and conference organizer. "Some of my students are already invited for meetings by industry professionals to get more information about their ongoing projects."



USPCAS-E master's student Leena Aftab, right, received first prize in the student poster competition.

THE BEGINNINGS OF CROSS-SECTOR COLLABORATION

From an economic perspective for Pakistan as a whole, the international conference marks the beginning of a new chapter between universities, industry and international partners to work together to address energy challenges.

"It demonstrated the importance of the USPCAS-E centers and the fruition of students graduating with advanced degrees to help lead the effort," said Dr. Sayfe Kiaei. "This project has brought a significant number of local energy experts to Pakistan's economy."

There are global ramifications, as well. Conference organizer Ahmad Saeed said: "Overall, ICSEP helped in putting USPCAS-E on the energy map of not only Pakistan but the world. It emerged as a credible energy research institute undertaking cutting-edge applied research in energy."

That's an important outcome, especially given the challenges that USPCAS-E faculty had to overcome in planning the conference. Chief among them were safety concerns that invitees had with traveling to Pakistan.

"At the moment, due to security challenges, Pakistan is not a favorite travel destination," said Saeed. "We had some speakers cancel due to concerns, but our experience with international conferences shows that the scientific community embraces greater courage to stand by their comrades in difficult times, and ICSEP was no different. The majority of our invitees chose to visit Pakistan, and I think the conference showed a softer side of the country."



Jerry Bisson



Omar Ayub Khan

"It helped bring people closer and address biases and any misunderstandings which may have existed for any reason. I would call the conference a resounding success."

BY JEN KENNEDY

MAY 2019

UET Peshawar National Conference explores investment scope in energy sector

On May 2, 2019, USPCAS-E UET Peshawar organized a day-long national conference in collaboration with the Khyber Pakhtunkhwa Energy and Power Department to explore investment opportunities in the energy sector.

The event brought together government officials, energy sector professionals, university researchers and representatives from donor agencies and private industries to discuss the province's energy resources.

The energy experts focused on public-private partnerships and presented policy recommendations to the government to facilitate sustainable development through innovative partnerships.





Putting the Focus on Teaching

USPCAS-E SUPPORTS CENTER FACULTY IN BUILDING THEIR PEDAGOGY TOOLKITS

A key focus area for USPCAS-E is pedagogy: improving course delivery methods and assessing the outcomes in the teaching and learning environment.

Engineering curricula needs constant adjustment to maximize alignment to the needs of society and industry. In addition to their content focus, engineering programs, especially at the master's and doctoral levels, should provide learning contexts for engineers to become excellent designers, problem-solvers, critical thinkers, team members and leaders. Active learning methodologies, including project-based learning (PjBL) and problem-based learning (PBL), can help to ensure these outcomes and that they align with

the needs and expectations of today's students.

ASU is working with USPCAS-E faculty at NUST and UET Peshawar to deepen their understanding of active learning approaches and benefits, to increase the use of active learning approaches in their instruction, and to better improve their use of these approaches to achieve desired outcomes. Part of this focus is to embrace the Scholarship of Teaching and Learning (SoTL), not only to improve instruction but also as an additional outlet for scholarship, creating a sustainable drive towards constant innovation. Faculty attendance at a SoTL conference helps achieve this goal.

With support from ASU, faculty from the current exchange cohort from NUST and UET Peshawar attended the Conference of the International Society for Exploring Teaching and Learning, in Tempe on October 10-13, 2018. There, they learned methods for improving their instruction, how to conduct research on teaching approaches, and how this research can lead to scholarly endeavors in the forms of presentations and publications.

"The key lesson learned during the conference was that it is very important to highlight the novel teaching practices among stakeholders (faculty, admin, students) in order to improve the student's learning.

The faculty while supervising interdisciplinary projects should also focus on the thinking process of the students rather than ensuring the success of the overall project.

Multi-sensory (sight, touch, sound, smell, taste) experience combined with digital stories is necessary to enhance the learning experience of the students."

—DR. AFFAQ QAMAR, UET PESHAWAR

"The conference provided a comprehensive insight to state-of-the-art teaching methodologies. It has enabled me to learn from experiences of faculty from diverse backgrounds.

The sessions were highly interactive and most of the presentations were complemented by involvement from the audience. They drew our attention to issues faced by faculty, students and administration in an intuitive manner and provided a vision of a highly functioning knowledge enterprise.

I am positive and will try to incorporate these lessons while working at USPCAS-E-NUST."

—DR. ARSALAN HABIB KHAWAJA, NUST

Promoting Active Learning in the Classroom

How do you transform the classroom experience and make the learning process engaging meaningful and relevant? How do you ensure that students really learn the material? These questions are at the heart of USPCAS-E efforts to reimagine the energy education curriculum at its partner universities in Pakistan.

The USAID-funded USPCAS-E program organized a professional development workshop in Pakistan for UET Peshawar and NUST faculty on active learning methodologies. Active learning is a process that involves students as active participants and partners in the learning process. About three-fourths of the 30 center faculty participated in the training to learn how they can improve classroom learning. Ten staff including research associates and lab managers also participated. The overall goal is to create a learning environment that promotes student learning and helps students excel as designers, problem-solvers, critical thinkers, team members and leaders.

The three-day workshop held January 15-17, 2019, was facilitated by Dr. Peter Rillero, an associate professor of science education at Arizona State University. This workshop was part of a comprehensive program designed specifically to improve teaching practices at the USPCAS-E centers and will lead to an Advancing Instructional Methods (AIM) certification.

The training is designed to be repeatable for the benefit of all current and future faculty and staff.

Workshop topics included higher-level thinking, questioning techniques, assessing and engaging through classroom response systems, and the scholarship of teaching and learning. The workshop provided participants with hands-on experience using two real-time student response systems, Socrative and Plickers. These apps allow instructors to collect data from their students through their own devices, including smartphones and laptops, or with verbal responses. Student response systems provide learners with real-time feedback on their understanding of a topic and they provide instructors with a gauge of their students' understanding of the material.

Dr. Muhammad Noman and Dr. Affaq Qamar from UET Peshawar and Dr. Arsalan Khawaja from NUST also facilitated sessions on active learning and shared their experiences from the International Society for



Exploring Teaching and Learning conference held in Arizona in October 2018. All three faculty recently returned from an exchange program at Arizona State University. The exchange program provides faculty and graduate students opportunities to expand their knowledge base and professional networks in an immersive program that exposes them to new ideas, methods and approaches to energy engineering.

The USAID-funded USPCAS-E program helped faculty to improve the quality of course delivery and assess outcomes in the teaching and learning environment in order to promote continuous improvement.

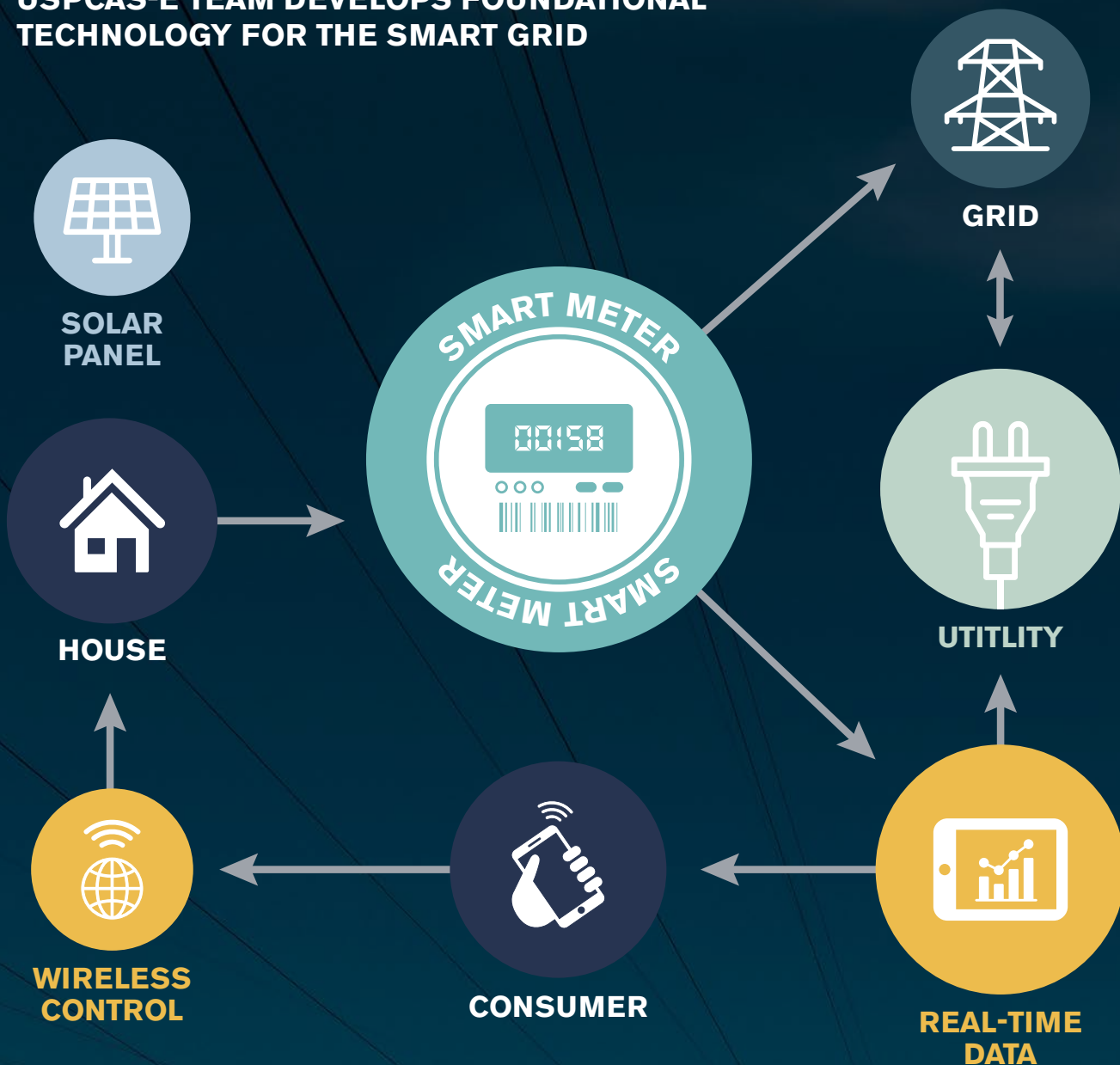
The six-month effort included classroom observations, a three-day pedagogy training, online modules and virtual Zoom sessions focusing on the scholarship of teaching and learning to provide actionable feedback to ensure that classroom instruction is on par with international best practices.

ASU worked with faculty at NUST and UET Peshawar to deepen their understanding of active learning approaches and improve their use of these approaches in the classroom. In the wrap-up session held on June 27, 2019, participants shared their findings and classroom practices.

Nine faculty and staff from NUST and UET Peshawar completed all program components and received a certificate of completion: Abdul Kashif Janjua, Nadia Shahzad, Muhammad Noman, Affaq Qamar, Khurshid Ahmad, Muhammad Hassan, Fahad Ullah, Muhammad Shoaib and Kaleem Ullah.

Smart solutions to addressing energy shortages

USPCAS-E TEAM DEVELOPS FOUNDATIONAL TECHNOLOGY FOR THE SMART GRID



Country by country, across the globe, utilities and governments are scrambling to install advanced metering infrastructure (AMI). Also known as smart metering, AMI provides the backbone for the power grid of the future, a grid where distributed energy resources like rooftop solar arrays, customer-owned battery storage devices and electric vehicles that feed their electrons back onto the power system are as much a part of the electricity resource mix as utility-owned power plants.

In Pakistan, AMI could help electricity suppliers better manage the grid, end electricity shortfalls and integrate customer-owned generation resources like rooftop solar arrays. These are some of the reasons Sajjad Zaidi, a professor of engineering at the National University of Science and Technology (NUST), worked with student scholars in the U.S.-Pakistan Centers for Advanced Research in Energy (USPCAS-E) to develop a home-grown AMI solution.

MORE THAN A METER READING

Traditional analog meters were designed for one thing: finding out how much electricity customers used so that utilities could bill them appropriately. AMI meters are digital, and they come equipped with two things that make them smart: computing power and the ability to connect with the utility over a communications network.

That network allows utilities to read the meters remotely, and the computing power within the devices supports using them for more than meter reading.

In Pakistan, AMI will help stem power theft, and that's a huge driver, according to Zaidi.

"One of the major reasons for power shortages in Pakistan is theft," he says.

Government researchers estimate that during 2017 and 2018, theft of service cost distribution companies some 53 billion Pakistani rupees or nearly \$379 million U.S. dollars. Zaidi's AMI system works via power-line carrier communications (PLCC), which means the signal travels over the power lines themselves. In areas where theft occurs through illegal line taps – a common approach in Pakistan – PLCC will minimize or even eliminate the problem, he says.

The meters Zaidi and his team are developing also have some important added features. Among them is bi-directional or net metering.

"Net metering is a billing arrangement that allows businesses and individuals generating their own electricity to deliver unused energy back to their local power grid and get credited back for its retail price," he explains. "It is available to customers who install



renewable fuel generators such as solar, wind, hydro or biomass sources and operate the generator in parallel with their electric company's electrical system."

BETTER POWER QUALITY, MORE CONTROL

In addition, Zaidi's meters serve as power quality sensors so that data can be used to operate the grid more efficiently and with greater reliability.

"Power quality analysis enables continuous monitoring," Zaidi says. It allows power suppliers to detect voltage and frequency excursions quickly, analyze causes and, he adds, take "timely corrective actions improving overall grid reliability."

Higher power quality also helps large industrial electricity consumers avoid expensive equipment failures that can result when voltage and frequency stray from standards.

Another key benefit of the meters is that they facilitate Home Area Networks (HANs). Zaidi explains that the AMI system "provides a platform to establish a two-way communication with the consumer's home, which enables smart meter connectivity with household devices like displays, load control devices and smart appliances."

Because the HAN lets consumers monitor and control household appliances, it can help people lower their energy bills. "The HAN is one of the major drivers of smart grid technologies," Zaidi says.

Why do utilities need these capabilities in their meters? Because these capabilities help power providers run the grid more efficiently while also allowing customers to be more active participants in the electricity arena.

STRONGER GRID, STRONGER PAKISTAN

Pakistan has been experiencing electricity shortages for years, says Ammar Yasser, corporate engagement specialist for USPCAS-E. Analysts now are predicting the energy shortfall will rise to 10,844 MW by 2020.

"Each and every member of the society needs to play an active role in controlling this drastically rising energy shortfall," he adds.



Smart metering supports that goal.

“The meters will help us control the excessive waste of electricity in our homes and small commercial units,” Yasser says.

That is achieved through multiple mechanisms that are facilitated via bi-directional communications. Along with supporting the HAN, the meters allow utilities to take power consumption readings multiple times a day. That, in turn, supports special rates, such as time-based rates designed to lower peak loads by charging people more when there’s too much load on the grid.

Smart meters feed utilities consumption readings throughout the day, so power suppliers will have more data for load forecasting, which could help them prevent widespread black-outs, Zaidi notes. “This technology can be used for system planning, as it gives a better understanding of the power trends in our country.”

In addition, utilities will be better able to manage the assets on their grids.

For instance, having consumption data on a frequent-interval basis – say every 15 minutes – allows the utility to see exactly how local transformers are loaded because they can see time-based consumption on the premises hooked into a particular transformer. This means utility managers will be able to swap out transformers that are over- or under-loaded with ones that are the right size, thereby eliminating waste and helping equipment last longer.

Finally, the AMI system will help Pakistan economically. There will be investment in technology and a more efficient, reliable grid to support industry and commerce.

This, he says, is why he and his team decided to work on advanced metering infrastructure.

“AMI is the primary building block of a modern grid,” he says. He adds, “Cutting down theft and peak loads – and allowing more individuals/ parties to contribute to the grid – will result in a better, more stable grid,

increasing investor trust in more development and a better economy.”

This economic boost will be even greater if the meters are designed and manufactured in Pakistan.

“The market size of smart grid technologies, and specifically smart meters, is huge,” Zaidi notes. “There is a lot of room for new products and new shareholders, which made this project a lucrative venture.”

Already, Zaidi and his team have interest from two major Pakistani electric supply companies. That’s not surprising given the competitive price and features – such as HAN support and theft prevention – that these meters offer.

Current smart meters cost around 70,000 rupees – about \$500 USD – and they are also prone to theft, Zaidi says.

“Users have no way of verifying the meter readings since there is no proper checking system in place. Our advanced meter and HAN interface will allow cross-checking and easy verification of meter readings while sitting at home. Moreover, our communication module uses a variety of communication methods, which will help in detecting any tampering done in the cables. Hence, within reasonable cost, we are offering more features as well as a user-friendly interface that current smart meters lack.”

Right now, the meters still await approval from Pakistani authorities before they can go into production.

Still, Zaidi says “prospects for commercialization are very bright. This project can contribute toward industrial and technological growth of the country.”

BY BETSY LOEFF



Research Q&A:

Improving Pakistan's Power Distribution Network

We talked to Assistant Professor Arsalan Habib Khawaja from USPCAS-E NUST to learn about his recently completed USAID-funded applied research project on fault detection systems for power distribution networks.

How did you come up with the idea for this project?

The power distribution network in Pakistan extends for thousands of kilometers, stretching from the power grid to the domestic user side in urban and rural areas. Although upgrades have been done from time to time, the overall infrastructure is old and requires frequent repairs. Mainly, once a line undergoes any fault condition, it requires immediate attention from line repair staff. The faults include damage to support towers, line conductors or faults due to external influence such as extreme weather conditions and short circuit between conductors.

Out of all such failures in the existing power distribution network, short-circuit faults are the most typical. I work in the field of electrical power, and the recurring problem was the primary driver behind my research project.

Now that you have shared this specific issue in Pakistan's energy sector, can you elaborate on your research topic?

The clearance of short circuit faults is the duty of local power electric supply companies that are responsible for

their respective urban and rural territories. More or less, all the electric supply companies handle such faults based on the fault duration. For instance, two standard divisions of such faults are 1) those cleared within twenty minutes and 2) those extending for more than twenty minutes.

The time duration also indicates the procedure for fault clearance. Faults cleared within twenty minutes are those faults which are non-permanent and occur as a result of events such as a flying bird or tree branch short-circuiting the conductors of the three-conductor (phase) power line. These faults are cleared automatically by a circuit breaker re-closure procedure by the feeder unit deployed at the grid station. Faults exceeding twenty minutes require manual intervention by line repair staff.

It is evident from electric supply companies' recorded data that short circuit non-clearing tripping faults occur frequently and require manual line inspection to trace out short-circuited lines or damaged disc/pin insulators.

The fault detection system that I worked on can localize short circuit faults using a minimum of two nodes between faulted and non-faulted states. The system is deployed where fault tracing is needed, whether on the main feeder length or branches. In an event, the span length closest to the fault location is identified by processing magnetic field signals deployed at respective nodes. An increase in the number of nodes improves the resolution with respect to the distance between faulted and un-faulted span length.

Real-world experiments were performed on dedicated 11kV overhead feeders of the I-10 sector in Islamabad Pakistan. The sensing modules were located at a span of 300 meters (with 100 meters between two consecutive poles), and the sensed data was sent to



the data center. The designed algorithm was used to localize the faulted span. To observe real-time data on-site, a Pico Oscilloscope was employed to examine the information on a laptop or PC.

An Arduino device with GSM module and ADC (analog to digital converter) was used to capture data from the sensor and send data to the server using GPRS data sim.

The setup has the following features:

- Noncontact magnetic field sensor that can be installed up to 10 feet away from distribution lines
- Wireless communication with the server over GPRS
- Own battery backup along with charging solar panel and charging circuit
- Two-way communication device controlled by server and data that can be accessed at any time
- Energy-efficient and customizable system that needs less than 250mA to run
- Waterproof casing to ensure outdoor safety

How is this project unique in its application?

I have developed an innovative tripping system for overhead power lines based on noncontact magnetic-field measurements. The fault span is located with the magnetic field measured along the transmission line by using highly sensitive, broadband, and a low-cost magneto-resistive magnetic sensor. Further, short circuit faults are located within a few seconds, using a minimum of two nodes between faulted and non-faulted states, thus eliminating efforts for manual inspection by line staff.

This project has multiple benefits, including a reduction in power outage times in events of short circuit faults for domestic consumers and preventing the danger of electrification during inspection and retrieval of the punctured pin and disc insulators.

The project is also fully scalable and implementable along the feeder to the consumer end, and it has the potential to be deployed for overhead transmission lines on top of distribution lines.

You talked about the uniqueness of this research. What are some benefits to industry and the overall economy?

An autonomous and portable device has been developed that can be deployed at various nodes of the power distribution network to localize the fault, reduce manual efforts, and decrease black-out timings. The developed system is sustainable in the following ways:

1. The per-node cost is 25,000 PKR. A practical approach can be installing each node on each of the laterals/branches of the feeder to trace the faulty node. The operation and maintenance costs are low, only 5,000 PKR per month for each of these nodes.
2. Distribution companies can benefit from the solution by improving their reliability indices, and thus increasing the revenue by cutting down system breakdown time.
3. The project has significant potential for various power distribution and supply companies and is adaptable to different terrains and weather conditions.

<< Assistant Professor Arsalan Habib Khawaja (left) with ASU Professor Bertan Bakkaloglu at the completion of his exchange scholar program.

Looking at the results of field experimentation and discussion with the Islamabad Electric Supply Company (IESCO) official, this project has great potential for being commercialized. IESCO and electricity providers across Pakistan have no reliable method to localize the short circuit fault other than manual scouting of the whole area. As mentioned earlier, the commercialization of this project will ensure the fast recovery of faults on 11kv distribution lines and prevent damage to help avoid adverse events. More features can be added to the device, such as current monitoring, peak load time calculations, and failure time monitoring. All this can be monitored through a secure remote server.

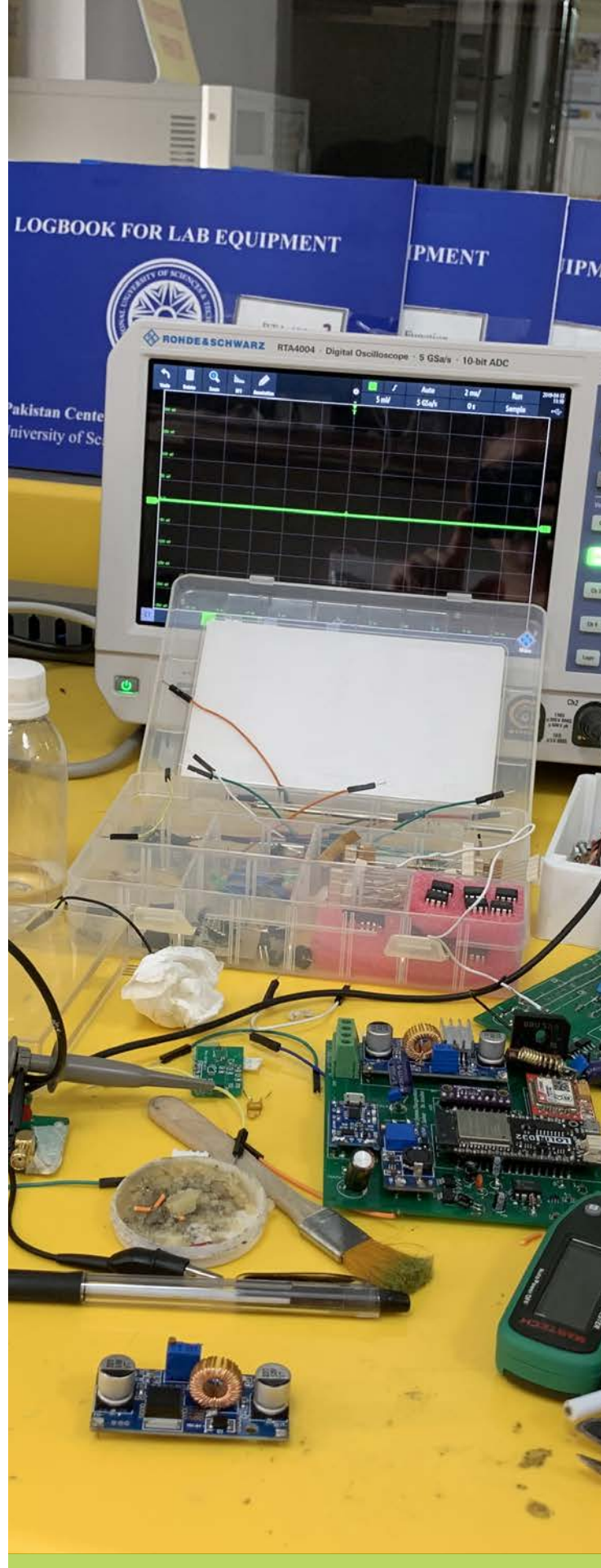
I want to add here that the marketing of this product will play a crucial role in commercialization. Marketing to other power distribution companies and stakeholders in Pakistan and participating countries depending upon the requirement of power distribution companies is essential.

How did Arizona State University support you?

First of all, I'm a U.S. exchange program beneficiary under the USPCAS-E project. Having spent sixteen weeks at ASU, I had the opportunity to work with very experienced and professional researchers in my field. I was able to work at ASU's state-of-the-art labs and also received

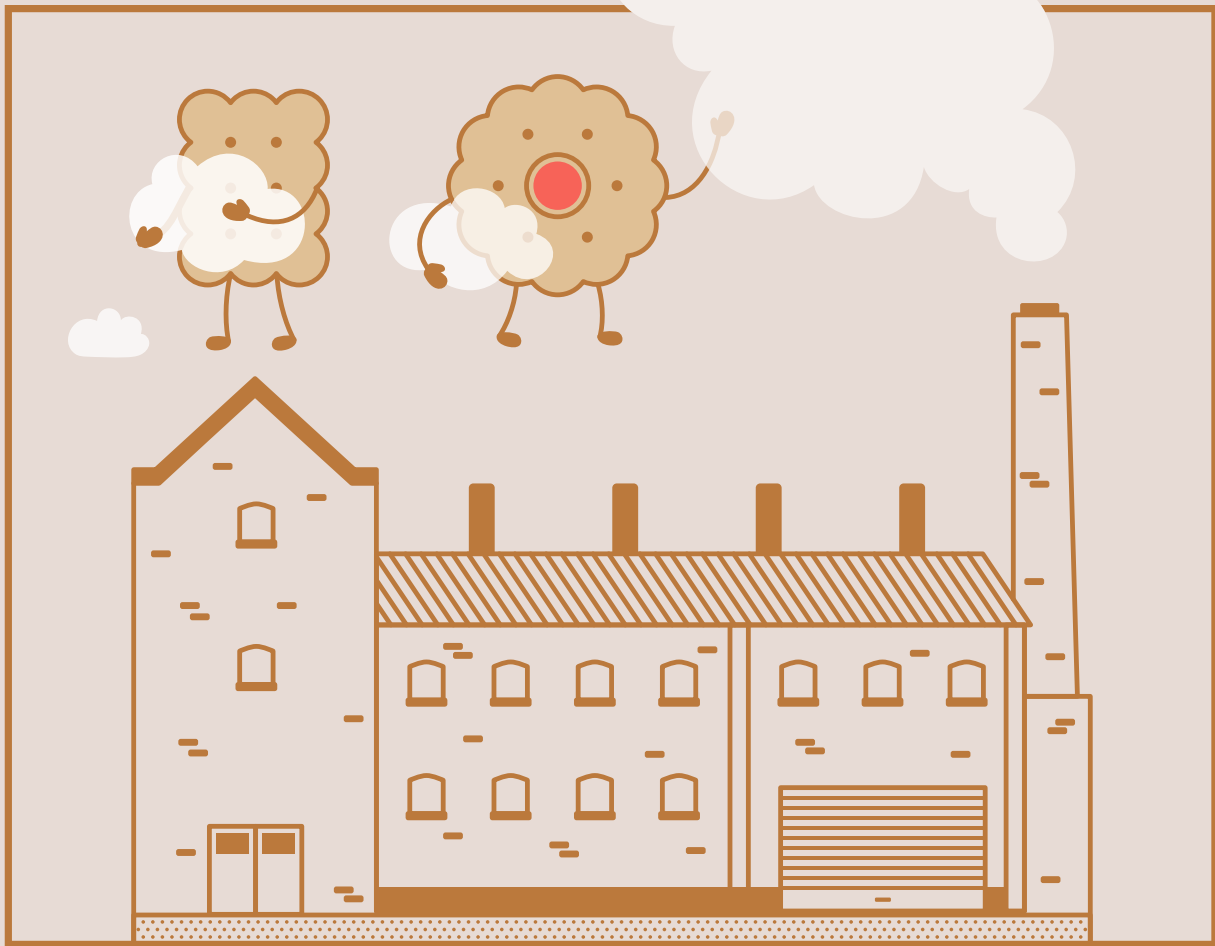
training on energy policy and entrepreneurship. I learned proposal writing and industry engagement techniques and applied those in the local context. I'm proud to mention that I worked on a joint applied research project with Dr. Bertan Bakkaloglu from ASU that focused on battery health monitoring. It was a rewarding experience for me to work with an IEEE fellow like Dr. Bakkaloglu.

Credit for the remarkable industry collaboration goes to Mr. Ammar Yasser, Corporate Engagement Specialist with Arizona State University. Mr. Yasser helped immensely to get the IESCO officials involved in the fault detection project. He supported us in identifying the right people and accompanied us to several coordination meetings. So overall, ASU helped not just the technical aspects but also with industrial collaboration.



TURNING LOSS GAIN

in cookie-factory
baking facilities



ILLUSTRATIONS BY QIUDI ZHANG

Turning loss to gain in cookie-factory baking facilities

It's been 66 years since former General Motors president Charles E. Wilson was misquoted as saying "What's good for General Motors is good for the country." The line took off because it's easy to extrapolate national benefit from corporate success. If industry can increase profitability and operate equipment in a greener way, such benefits also impact society at large.

That's the hope behind recent research conducted by the U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E). An applied research project has resulted in energy-saving equipment that's likely to deliver considerable savings to Pakistan-based Coronet Foods, a subsidiary of English Biscuit Manufacturers.



KEEPING ENERGY FROM GOING UP IN SMOKE

Natural gas prices have skyrocketed in Pakistan. This past September, Pakistan's Economic Coordination Committee (ECC) approved a 57 percent increase in gas prices for the commercial sector. General industry saw a 40 percent increase and the power sector took a 57 percent hike.

"Industry will be hit squarely," says Ahmed Sohail Khan, the USPCAS-E technical advisor with the University of Engineering and Technology (UET), Peshawar. "Gas prices have more than doubled in recent months."

That's bad news for bakeries like Coronet Foods, which relies on gas for production.

"Coronet Foods is one of the largest biscuit producers in Pakistan and our production mainly depends on gas," says Asif Sultan, a professional engineer and principal investigator on a joint research project with USPCAS-E. "The share of gas in our utility bill is 80 percent in terms of monetary value."

Due to limited resources and the low pressure of natural gas, Sultan says Coronet uses a combination of natural gas and liquified petroleum gas (LPG) to fulfill plant requirements. Those requirements necessitate an average monthly consumption of around 27,33,72 cubic meters, of which 70 percent is LPG and 30 percent is natural gas.

Sultan adds, "We require a huge amount of hot water in different areas of production processes like mixing areas, washing areas and kitchens. Our hot water requirement is around 200 gallons per hour, and we are using gas

geysers (water heaters) for this operation. These gas geysers are adding a huge amount to our utility bill."

Worse, much of that money is essentially drifting up the flues of baking ovens.

"For most fuel-fired equipment, a large amount of the heat supplied is wasted as exhaust or flue gasses," notes Saim Saher, an assistant professor of engineering at UET Peshawar. "These gasses still hold considerable thermal energy. In many systems, this is the greatest single loss of heat"

But, Saher continues, the loss can be mitigated.

"The energy efficiency can often be increased by using waste heat gas recovery systems to capture and use some of the energy in the flue gas."

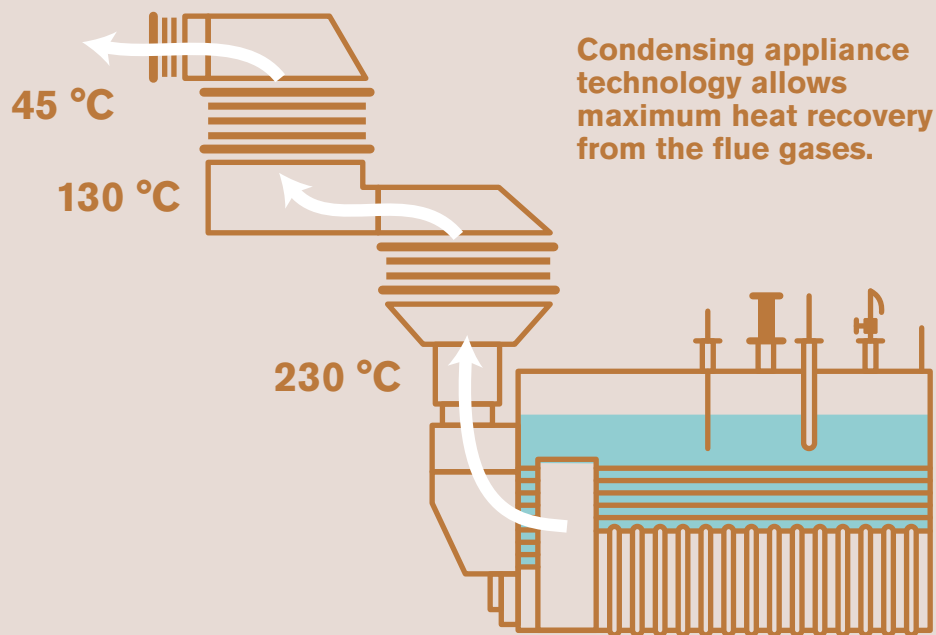
Working with Saher and some of his students, Coronet Foods has been developing a heat-recovery system.

"The primary aim of the research was to design and construct a system that will recover 70 percent of waste heat energy from natural gas furnace ovens and make it usable for water heating purposes. Currently, we are wasting this energy (by releasing it) into the environment."

INDUSTRY DRIVEN, ACADEMIA SUPPORTED

"This is basically an industry-driven project," says Saher. "The principal investigator, Asif Sultan, came up with the idea and we discussed it before developing the proposal."

To support the research project, Saher advertised a student job and hired Yaseen Mehmood, a graduate scholar and mechanical engineer. He designed the device



that would be used in the waste-heat recovery system and worked with Sultan to finalize and approve the design.

"The company management is very encouraging in terms of innovation," Sultan says. "When I came up with this idea, there was no resistance from approving authorities and, in fact, they motivated me to pursue the project."

Part of the payback of this project comes from strengthened bonds between industry and academia.

He adds that there were frequent exchange visits between Sultan and the scholars, where each visited the other's site, a move that proved to be a strong relationship builder.

"Normally, the private sector does not trust the capabilities of academia to provide design solutions," explained Saher. "This project has boosted trust."

In addition, it served as a showcase for industry leaders to discover the benefits of academic research.

"Most factories in the country are using their regular production processes and not considering energy conservation or efficiency," Saher says.

"This is a unique approach in Pakistan, particularly when we talk about the food industry."

The team hopes to showcase the finished project to other bakeries and spread this efficiency measure nationwide.

OUTSMARTING SULFUR

Cookie-baking ovens can reach temperatures as high as 250 degrees Celsius or 482 degrees Fahrenheit. The heat-recovery equipment extracts much of the heat and discharges gasses at 75 degrees Celsius or 167 degrees Fahrenheit.

"Whenever you extract heat below 100 degrees Celsius there is condensation and sulfur dioxide in the flue gasses, and this could corrode the equipment," says Khan.

This has been one of the challenges of the project.

To combat this, the UET Peshawar researchers leveraged materials science along with engineering in designing the equipment. The prototype unit was designed with stainless steel because it is resistant to corrosion, allowing the team to cool flue gases more completely and capture more of the thermal energy.

"The lower the flue gas temperature can be reduced, the more efficient the condensing appliance technology," notes a report produced by the research team.



Right now, the team is testing a second version of the heat-recovery device because moisture was getting trapped inside the first unit.

"We have redesigned the model based on testing and are currently fabricating a new product," Saher says.

He says this time the team created a condensing economizer, a device that removes heat from hot flue gases by passing them through coiled pipes.

"Once complete, we plan to replicate this with the baking industry across Pakistan," he adds.

"We will invite representatives of industry to visit the factory and see results of our project."

The results should be impressive. Currently, Coronet Foods invests 1,211,760 Pakistani rupees or nearly \$9,000 per month in natural gas and LPG for water heating only.

"After installation of the heat recovery system, we save every month," Sultan says.

Even if the final heat-recovery system only operates

at 40 percent efficiency, it is likely to recover system costs in less than one year. And, because it was a joint research project with UET Peshawar, the benefits can spread throughout Pakistan.

"If companies are implementing different cost-effective solutions, they are not disseminating these practices to a larger audience," Saher says. "Our project seeks to benefit other players in the market by sharing our findings and results."

In fact, the project may go beyond bakery ovens and wind up benefiting many businesses in Pakistan. Khan also envisions this type of condensing economizer being used in five-star hotels in the country's northern mountains.

"There is no natural gas because there is no pipeline for these areas," he says. "They operate boilers with diesel, and that has a heavy sulfur content. This design holds enormous potential for industry."

BY BETSY LOEFF



Vision and Technology: UNIDO Taps USPCAS-E to Expand Energy Options

South Asia is cited as the major producer of biomass resources. This includes agricultural and livestock waste, wood residue from forests, and industrial wastewater from the agriculture industry. Thailand derives nearly one third of its energy from biomass using biomass gasification technology (BGT) leveraging agricultural waste. Through a controlled and enclosed burning process, BGT creates syngas, a fuel for electricity generators.

It's a cost-effective way to produce electricity while cutting down on the pollution from open agricultural trash burning. However, Pakistan hasn't significantly built out its biomass capability yet. That's why the United Nations Industrial Development Organization (UNIDO) funded the U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E) at the National University of Sciences and Technology (NUST) to lay the groundwork for developing Pakistan's biomass energy capacity and to help generate interest for this energy source within the business community.

Scholars from USPCAS-E NUST won the grant in 2015 through a competitive bidding process. The success of that first project led to more collaboration. Most recently,

USPCAS-E has been providing energy efficiency training and a demonstration facility that will show the potential users the research and technology in action.

DISCOVERING THE POSSIBILITIES

Pakistani Small and Medium Enterprises (SMEs) need to know about biomass gasification technologies (BGT), says Muhammad Zubair, assistant professor of thermal energy engineering at USPCAS-E NUST and principal investigator on the biomass UNIDO projects.

"UNIDO thought it was better to do some capacity building before introducing gasifiers into the market," he explains.

To accomplish the task, UNIDO awarded USPCAS-E a \$380,000 USD grant.

The project involved evaluating the energy requirements of SMEs in Pakistan – the potential users of gasifiers – as well as how these businesses currently meet their energy needs. That is, are they on the grid or using alternative means, such as diesel or gasoline generators? Can they shift to power systems based on biomass gasification technology?

Along with looking at the potential users, the team had to evaluate potential equipment and service providers who could build and help operate the systems. The researchers also identified financial resources to help businesses invest in BGT as well as potential supply chain resources for the raw agricultural by-products burned to make syngas.

"We have data about the feedstocks available in different regions of Pakistan," Zubair says. "We have also documented the requirements of communities and SMEs and can show how much a business can save."

For instance, the researchers found that a small business using a diesel or gasoline engine is spending six times more than the cost of a biomass gasification system (BGT). The cost of producing one unit of electricity from BGT ranges from 5-10 U.S. cents, depending on the cost of biomass feedstock.

Reports on these findings were only part of the results of this two-year effort. Zubair and his team – which included several students – created business plan templates to help businesses evaluate the investment and secure financing. The team also held workshops to promote biomass technology and created manuals for the laypeople who would use and run the facilities.

The NUST team also created curricula on BGT for undergraduate and master's programs. They even developed curriculum for vocational training institutes to ensure that people of many educational levels could be ready to work in the BGT industry.

Then the team held an international conference to further educate the business community about BGT and to connect them to relevant resources.

"We invited all the companies related to biomass energy to display their projects and we had a good turnout. The conference also facilitated several memoranda of understanding between local and international companies for technology transfer," Zubair says.

NURTURING GROWTH

For the second phase of this UNIDO-funded initiative, Zubair and USPCAS-E scholars are continuing their work of cataloging resources, educating businesses and documenting financial concerns related to BGT. They're adding to their studies on supply chain and mapping out how to move agricultural by-products to the BGT plants that need them.

"A major component of this project is biomass cluster development," Zubair notes.

A business or technology cluster is a concentration of interconnected and related suppliers, businesses and institutions focused on a specific technology in a geographic region. Technology clusters aim to harness resources, promote technology adoption and increase the productivity of cluster participants. California's Silicon Valley is a prime example of a technology cluster.

In addition, Zubair's current work includes a biomass demonstration project in a plywood factory. This facility serves as a showcase for other Pakistani business operators that demonstrates the benefits of these systems.

"They have wood chips and residues. We are now going to set up a 50-kilowatt system. We'll provide the technical assistance and we'll operate it. Then we'll get the research



data and have the patent for the system," Zubair says.

"This will be our highest-scale project outside the academic environment," he continues. "We'll get more projects by demonstrating that successful project, so I'm hopeful it will help with sustainability" for the USPCAS-E program itself.

That is, consulting on BGT systems could become a healthy revenue generation source. According to Zubair, creating the technology cluster will be key to that effort, and USPCAS-E will be positioned as the hub.

HELPING BUSINESSES MAKE MORE, USE LESS ENERGY

While the BGT projects are designed to help Pakistani businesses make their own power on site, prior work done by USPCAS-E scholars also earned them the opportunity to help teach businesses to use less energy overall.

That's important because, right now, Pakistan is seeking to adopt energy efficiency measures. For example, the textile industry makes up about 62 percent of Pakistan's exports and employs 45 percent of the total labor workforce. However, it could be more vital and profitable if it employed similar energy efficiency measures used by neighboring export competitors.

"The textile sector energy costs in India are one fifth of what they are in Pakistan," says Ali Qureshi, an expert in sustainability and biomass systems with the United Nations Industrial Development Organization (UNIDO). "In Bangladesh, the energy cost is one ninth of what it is in Pakistan."

High energy bills are putting Pakistan's largest export industry at a disadvantage, and that's one reason UNIDO is ramping up to deploy energy efficiency training on a wide scale.



SPREADING THE WORD

Qureshi calls the recent training sessions “capacity building.” Specifically, his organization is trying to build a pool of certified energy auditors and energy managers. Knowing where you currently stand through energy audits and then learning to mitigate waste are critical skills for cutting business costs and making Pakistani enterprises more competitive on the global stage. Significant savings can be realized through efficiency measures.

“Although there is potential for energy efficiency, almost 10 to 40 percent in typical buildings and industries in Pakistan, less than five percent of our organizations implement energy efficiency,” says Muhammad Bilal Sajid, assistant professor of thermal energy engineering at USPCAS-E NUST.

As a starting point in this educational effort, the UNIDO team benchmarked Pakistani energy consumption in five key industrial sectors and compared them to potential energy savings via international best practices. Overall, they found that the Pakistani textile market could shave around seven percent off its energy expense, while the ceramics industry could save 10 times that number: 70 percent, says Qureshi. Paper and pulp product manufactures could save 22 percent on their energy bills, TV manufacturers stand to save as much as 45 percent, while the foundry industry could cut 12 percent from its energy costs merely by optimizing processes associated with its coke ovens.

“We focused on these five sectors because there is a lot of potential for energy savings,” says Ali Qureshi. “Since we are going through an energy crisis, our focus should be on the energy efficiency side.”

“Among the list of things that should be evaluated for savings potential, you’ll find lighting, motors, boilers, compressors, pumps and heating or air conditioning equipment,” Sajid says.

Motors, compressed air systems and building envelopes – the walls, windows, doors and other physical separators between a building’s conditioned and unconditioned spaces – are the areas where the savings reside, he adds.

COMING UP TO STANDARDS

Along with teaching efficiency measures, the UNIDO program will teach continuous improvement similar to guidelines from the international organization for standardization.

“We are working on establishing an energy management system in industry that is in line with the international standard, ISO 50001 energy management systems,” says Qureshi.

UNIDO’s program also served as the foundation for a new elective course in NUST master’s program, Industrial Energy Management. This class draws directly from the UNIDO trainings, Sajid says.

That training reached approximately 20 people associated with the USPCAS-E program, as well as energy consultants, industry representatives and participants from the public sector. Many will continue with the program as trainers, consultants or participants in the ISO 50001 energy management system initiative. Together USPCAS-E and UNIDO aim to increase energy efficiency, reduce greenhouse gas emissions and create new job opportunities for Pakistan’s energy professionals.



An energy-efficient zigzag brick kiln emits white smoke reducing environmental impact.

Building energy efficiency brick by brick

Pakistani industry and academia join forces to improve energy efficiency in the brick kiln sector

Pakistan's Higher Education Commission's Technology Development Fund (TDF) Program awarded PKR. 8.681 Million (approximately \$56,000 USD) to principal investigator Muhammad Bilal Sajid for the project "Retrofitting of Brick Kilns to Improve Energy Efficiency and Environmental Impact" as part of its second call for proposals, 2017-2018. This funding is part of each center's goal to raise at least \$1 million over the funded life of the project. Fundraising is key to the long-term financial sustainability of the Centers for Advanced Studies in Energy at NUST and UET Peshawar, and together the centers have raised more than \$2 million to date.

"We will promote energy efficiency technologies on a large scale through a systematic approach," recalls Dr. Muhammad Bilal Sajid, an assistant professor of thermal energy engineering at U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E), National University of Sciences and Technology (NUST).

Fixed Chimney Bull's Trench Kiln (FCBTK) technology is the most widely used brick firing technology in South Asian countries, including Pakistan. The FCBTK design leads to poor combustion, high fuel consumption and high particulate

matter (PM) emissions. It's estimated that approximately 0.5 million tons of untreated PM, sulphur oxides (SOx), and greenhouse gases are emitted from these kilns annually. Sajid's project developed an indigenously retrofitted brick kiln based on a zigzag design that improves combustion while reducing fuel use and particulate matter emissions.

GOVERNMENT + INDUSTRY + ACADEMIA

"The idea of this research project was jointly conceived by NEECA and representatives of All Pakistan Brick Kiln Owners Association," adds Engineer Asad Mahmood, Manager Technical at National Energy Efficiency & Conservation Authority (NEECA). As part of its efforts to promote energy efficiency in the building sector, NEECA realized that establishing model zigzag technology-based brick kilns would raise awareness about its economic and environmental benefits.

"Since USPCAS-E aims to address national issues in the field of energy, we joined hands with the academia for this national cause and also to help us in applied research," says Mahmood. In the zigzag technology, bricks are stacked to guide airflow in a zigzag path, while fire moves in a rectangular track through the bricks. The zigzag technology increases the airflow path length resulting in better combustion, a higher heat transfer rate and uniform temperature across the kiln.

IMPROVED DESIGN FOR A CLEANER ENVIRONMENT

“Our proposed technology is very similar to existing brick kilns in Pakistan, yet it offers superior environmental performance and is economically attractive,” notes Dr. Sajid. The design includes:

Installation of Blower Assembly: The zigzag design consists of a blower assembly to force the inflow of more air (and hence oxygen) into the combustion zone of the brick kiln resulting in better fuel combustion. The blower assembly includes (i) a blower/fan, (ii) a variable frequency drive (VFD), (iii) ducting, (iv) a control system, (iv) a power supply (grid-connected, solar panels or a generator).

Change in Brick Stacking Pattern: Airflow is inducted by the blower, and the zigzag brick pattern results in better heat transfer from hot gases to bricks.

Insulation of Brick Kiln: Nearly 35 percent of thermal energy escapes from the conventional brick kiln. Zigzag design-based brick kilns address this issue by building walls, floors and top of the brick kiln with better insulation.

Training of Workforce: Training of the workforce is the critical last step in ensuring that retrofitted brick kilns operate smoothly.

“ASU has always been very dynamic in promoting industrial-academic linkages. The ASU team played a pivotal role in engaging NEECA and the Brick Kiln Owners Association, arranging field visits and meeting with key stakeholders. After several months of effort, a proposal was prepared and submitted to TDF for sponsorship,” remarks Dr. Sajid. “The proposal writing and corporate engagement trainings organized by ASU helped me immensely to develop the proposal,” he adds.

SCALING UP FOR A GREENER PAKISTAN

In October 2018, the government of Pakistan’s Punjab province put a three-month ban on brick kilns in the region as a control measure for smog, a type of air pollution caused by a combination of smoke and fog mostly during winter. That’s one of the reasons why Tayyab moved ahead with the idea of utilizing personal funds, while the TDF proposal was still under review process.

“We are always looking into ways to improve efficiency and product quality, and ultimately reduce production costs,” remarks Tayyab Ikram, a brick kiln owner.

“The improved design saved up to 30 percent in fuel consumption and resulted in nearly 80 percent reduction in particulate matter. The payback period for retrofitting is a maximum of two years,” he adds.

“The Brick Kiln Owners Association was very supportive during various phases of this project. Furthermore, the local manufacturing industry is fully capable of fabricating the blower assembly per our requirement. As a next step, we are exploring ways to automate coal feeding,” says Tayyab.

Both Sajid and Tayyab envision making this kiln an exemplar for other brick kiln operators in Pakistan. They firmly believe that this improved brick kiln design has enormous potential in Pakistan and will help in transforming the brick kiln sector.



A locally engineered blower assembly reduces fuel consumption and improves quality of bricks.



USPCAS-E equips Pakistani communities with the latest technology

APPLIED ENERGY RESEARCH OFFERS EFFICIENCY AND QUALITY IMPROVEMENTS TO DRY FRUIT PROCESSING USING SOLAR-BIOMASS HYBRID TUNNEL DRYERS

Agriculture is often considered the backbone of Pakistan's economy. With technological advancements, farmers are switching from traditional farming techniques to innovative methods that increase production and maximize sales. Farmers in the Swat region of Khyber Pakhtunkhwa are using new techniques to dry fruit. Although fruit dehydration involves more processing time, it has many benefits: shelf life is increased, storage space is reduced, and transportation is easier. These factors also increase the number of available markets and the selling price.

This was the motivation for Dr. Suhail Zaki's idea of bringing solar technology to the fruit drying process in his applied research project, "Development of a Large Capacity Solar-Biomass Hybrid Tunnel Dryer in Swat for Long Term Preservation of Fruit Including Persimmon." Zaki is a professor of renewable energy at U.S.-Pakistan Center for Advanced Studies in Energy at

University of Engineering and Technology Peshawar.

"If fruit drying is managed efficiently, we can earn good revenue not only in the local industry but also in the form of foreign exchange by exporting these items and thus positively impact Pakistan's farming community," says Zaki.

SOLAR-BIOMASS HYBRID TUNNEL DRYERS

This applied research project focused on the design, development, testing, and commercialization of solar dryers to process persimmons and other fruits in the Swat Valley. Solar-biomass hybrid tunnel dryers utilize the energy of the sun and wind to dry agricultural products, preparing them for storage and processing. The fruit is spread in even layers on drying racks inside the tunnel. The air below the semi-transparent collector is heated by the sun and spreads throughout the tunnel. The increased temperature decreases the relative humidity of the air, thereby allowing the air to dry the fruits efficiently. Also, the product is completely protected from external environmental impacts such as rain, insects, and animals.

The locally trained craftsmen can build the entire structure and transport to village areas for installation, primarily on rooftops or open fields.



Scholar excursion opens minds and hearts

"This trip was one of the most memorable ones of my life!" recalls Asfandiyar Khalid. "After visiting the Hoover Dam and Griffith Observatory, I realized how these places were converted into great tourist spots which in turn created employment opportunities and prosperity in the region," he says.

As part of the USPCAS-E exchange program, scholars from Pakistan were taken on a week-long cultural excursion to the Grand Canyon, Hoover Dam Power Plant, Griffith Observatory, Ivanpah Solar Power Plant and several other destinations.

"I observed Native American culture, their way of living, their houses and their dance which was modeled at the Grand Canyon," said Qandeel Rehman.

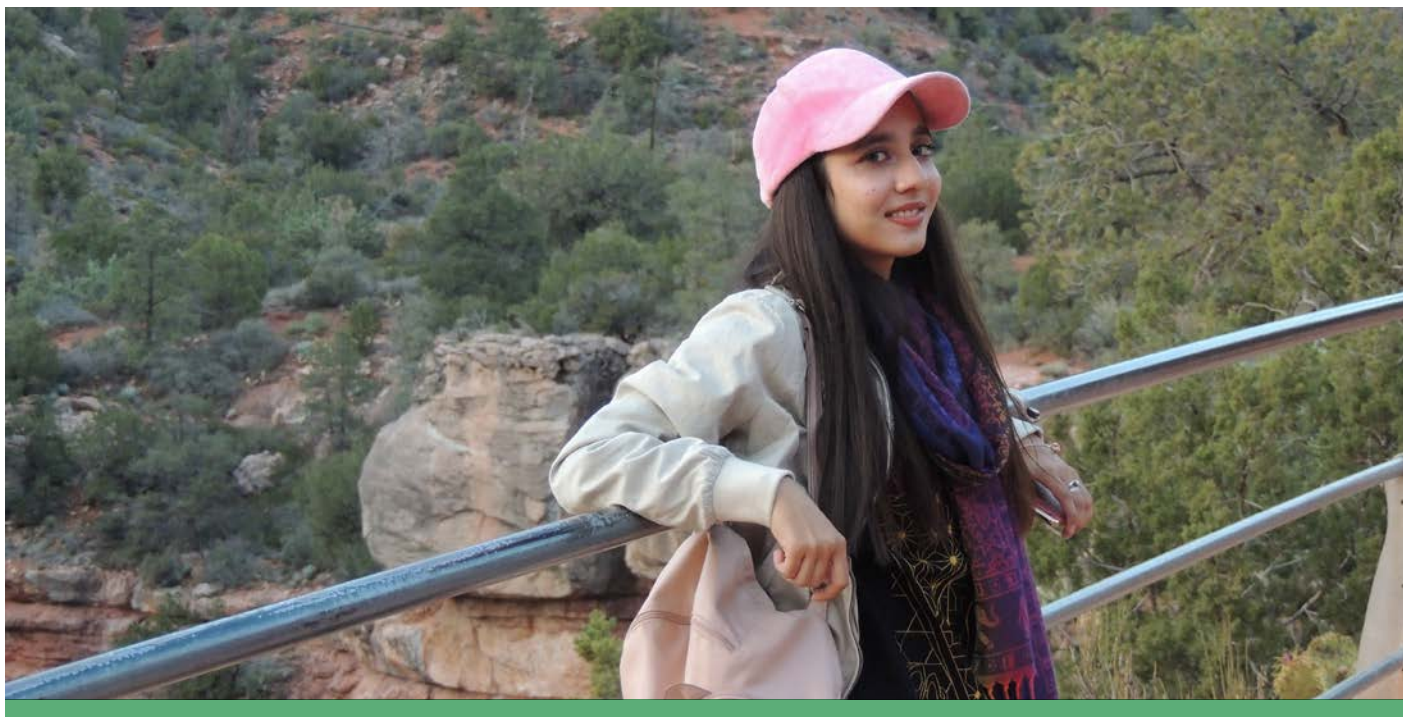
The Hoover Dam visitor center and power plant visit exposed the exchange scholars to the massive concrete structure built in the 1930s on the border of Arizona and Nevada. They learned about energy policy and its role in the construction of Hoover Dam for irrigation and power generation.

"All values of American culture are worthy of respect, and above all the discipline and time management of Americans is very appreciable," says scholar Shazmina Jamil. "Tourism is not only fulfilling our wish to visit a place, but there also are multiple dimensions to it, for example, meeting new people, learning about their culture, making a comparison of the two countries, and learning to make our nation better in a more diverse way."

Haider Sami remarked that this excursion was an amazing and life-changing experience for him.

"It has been an action-packed learning adventure that reflected not only American culture but gave us a chance to interact and share our cultural values with fellow Americans. Going to Universal Studios and Disneyland was the best part of the whole tour, a truly magical experience," Sami says. "I always used to shy away from scary rides and had a tough time untangling the fun and fear of experiencing something out of my comfort zone, but being able to make that leap now feels like nothing less than a huge accomplishment."

Overall, this fun-filled educational trip helped the scholars learn about leveraging local industries to promote social values and boost the local economy, and looking at how renewable energy can be implemented in multiple sectors, including the tourism sector, at venues such as Disneyland and Universal Studios.



Lights going off turn on scholar's interest in energy

Mehak Asad, a master's candidate at the University of Engineering and Technology–Peshawar (UET Peshawar), remembers exactly when her scholastic interest began to shift to the world of energy.

"I was in my bachelor's program," she recalls. "We had semester exams going on and, in the evenings, we had electricity outages. I realized how crucial it is to solve our energy crisis. If we didn't, millions of people would be unable to do their work."

Mehak comes to her master's studies and participation in the USPCAS-E program with a strong background in electrical engineering and a focus on communications. While earning her bachelor's degree, Mehak learned computer programming, as well as the ins and outs of microcontrollers, circuit analysis, data signal processing and more. This provided a solid foundation for the turn her studies took once she came to the U.S. as part of the USPCAS-E scholar exchange program and began studying at Arizona State University.

"Here, I am working on machine learning and how it can be used in power systems," she says. "I hope that by the end of this program, I will be able to use the techniques I've learned to solve power system problems."

Mehak also hopes to continue her research after earning her master's, and she's already thinking about pursuing a doctorate degree.

"It's a harsh reality that for females in Pakistan, pursuing education is difficult in one way or other," she says. "USPCAS-E provides a great platform, especially for females."

Mehak says USPCAS-E support goes beyond financial aid and scholarships.

"Females are always encouraged to participate in different events. Also, many female students have been to the U.S. under the exchange program to get international exposure," she explains.

Mehak, who says she always wanted to be an engineer, will be the first female engineer in her family, something her parents and siblings applaud.

"My family was always a source of encouragement and motivation for me," she says.

Loyalty to country is also a driver for Mehak.

"Pakistan has been facing an energy crisis for years," she says. "We have been hearing about this issue since childhood, and we know the problems face by people due to unscheduled outages. USPCAS-E is particularly aimed to solve the energy crisis in Pakistan. I felt that this is the correct place from which I can contribute to solve the problem."

BY BETSY LOEFF

On her drawing board: fuel cell solutions

“Most people don’t know this, but I am a good sketch artist,” says Afaf Ali, a master’s candidate at the University of Engineering and Technology – Peshawar (UET Peshawar). “I also do painting when I have enough free time,” she says.

Today, those kinds of creative outlets get little of Ali’s attention. As a USPCAS-E scholar and exchange student at Arizona State University, she’s been hard at work conducting research related to her master’s thesis, which focuses on the development of a non-platinum catalyst for the fuel reduction reaction in proton exchange membrane fuel cells (PEMFC).

Used primarily for transportation, PEMFC generate electricity through chemical reactions promoted through a catalyst, which usually is platinum, a very pricey element. A recent Reuters article noted that platinum is some 56,000 times more expensive than steel. Because of this, even the least expensive fuel-cell vehicles are twice the cost of similar electric vehicles.

Still, fuel cells hold great promise.

“This technology, if implemented at an economical cost, can be a breakthrough in the electric car industry,” Ali says.

Backed by this belief, she plans to pursue a doctorate while also engaging with industry to make her research practical and impactful.



SCIENCE AS SERVICE

As a USPCAS-E scholar, Ali has also worked on wind energy and it’s potential in Pakistan, in which coastal areas have much to offer, she notes. Like most students in the program, she’s committed to helping Pakistan overcome its energy shortages.

“Five years from now, I would like to see the commercial implementation of my current research work,” she says.

“Facing 10 to 12 hours of power cuts in the major cities of Pakistan surely makes you aware that something is really wrong with current energy policies and systems,” Ali says. “In rural areas, the situation is far worse. No electricity at all. We need to generate, conserve and secure energy.”

Ali adds that when she looked at the Pakistani energy crisis after getting her Bachelor’s degree in chemical engineering at UET Peshawar, she “felt a responsibility” to be part of the energy sector.

Service to country comes naturally to Ali, perhaps because her father is a retired air force officer. The eldest of four daughters, she says her dad urged all his girls to pursue scholastic excellence.

“His efforts led me to my path and my other sisters, as well,” she says.

While her father’s encouragement, Ali has gone beyond academics to pursue self-development in other areas. She’s attended a boot camp for social entrepreneurship and attended conferences on sustainability and green energy technologies.

So, no, despite her artistic talent, Ali doesn’t spend her days sketching landscapes and still life scenes. But, she is a dedicated USPCAS-E scholar eager to return to her native land this December. “I am looking forward to completing my research and being a part of positive change in Pakistan,” she says. “We are the future that can save our country from the immense energy crisis. That is what motivates me.

BY BETSY LOEFF



Working to ensure a bright future for Pakistan

Growing up, Shazmina Jamil had to change minds. She explains that in Pakistan, people don't see girls as engineers, engineering is seen as a male-only realm. But she definitely had an engineering mindset from an early age, being curious about how things worked and taking things apart to see the inner workings for herself.

"I always had a passion for learning new things and a thirst for understanding the latest technologies," Shazmina explains.

She worked to change minds bit by bit in her community and family, changing the concept of who can be an engineer.

"The concept that only boys could be engineers was a concept that I had to overcome. I did that and I am the first girl in my family to become an engineer."

Shazmina is now a graduate student in electrical energy/power systems at the U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E) at the University of Engineering and Technology (UET) Peshawar. She's from Kohat, in the Khyber Pakhtunkhwa province of Pakistan. After earning her undergraduate degree in electrical engineering

at UET Peshawar, continuing on as a graduate student with USPCAS-E was a natural next step

"When I was getting my undergraduate engineering degree, I knew that I wanted to do research in power systems. After graduating, I decided to pursue a master's degree," Shazmina says.

ENVISIONING A 24/7 POWERED FUTURE FOR PAKISTAN

Shazmina wants to see full-time availability of power in her home country. She wants everyone to have the freedom to pursue any activity without worrying about power availability.

"I want my people to have 24-hour access to power. I want everyone to be able to study when they want, to cook when they want, and to do anything that they want without worrying about outages," Shazmina explains.

Shazmina's research focuses on phasor measurement unit (PMU) data for fault detection. Her work is like that of a detective, looking for system faults before they happen in order to prevent overloads and blackouts.

"I am working on PMU data for fault detection in different parts of power systems. This is important for Pakistan because currently, we can't always detect faults and prevent blackouts. In Pakistan, we now have PMUs so with this new knowledge I can better help Pakistan manage its energy network."

Shazmina knows that load shedding events impact the quality of life in Pakistan and her work focuses on identifying potential issues before systems and transformers are overloaded and power outages occur. Power outages can affect Pakistanis for 12 to 16 hours a day greatly interfering with economic activities and everyday life.

THE POWER OF EXCHANGE

Shazmina says that the best part of her USPCAS-E experience has been the exchange program.

“The exchange program was an amazing experience. I am excited to be learning these things in the U.S.,” she says. It’s really awesome working in the lab. I have learned a lot of things but I am most excited about learning the way that research is done at ASU and will take that knowledge back with me.”

In addition to learning about the research process in her lab at ASU, Shazmina has also learned a lot about American culture in her first visit to the United States.

“There are many misunderstandings about America in my country, so it’s nothing like what I expected. The American people are very welcoming and adaptive, accepting people from all different countries and cultures.”

Shazmina echoes the sentiments of other exchange scholars in her admiration of the good time management, hard work, rule following (like traffic laws), and the management of public spaces and venues like Disneyland and national parks that she has observed in the United States. She noticed that even very crowded areas are well managed in the U.S.

“We need to implement these things at home in Pakistan.”

Shazmina observed that it’s easy to follow her culture when she’s at home in Pakistan but being immersed in another country gave her a new appreciation for her own culture as well as an appreciation for other cultures.

“I really learned to follow my culture and value my own norms while living far away from home and at the same time, appreciating and accepting others.”

After graduation, Shazmina plans to continue her research and hopes to pursue a Ph.D. in the United States.





Finding her place in the sun— and harnessing it for energy

Muneeza Ahmad is from Lahore, Pakistan and is currently enrolled in the Energy Systems Engineering program at the U.S.-Pakistan Center for Advanced Studies (USPCAS-E) at the National University of Sciences and Technology (NUST).

Even as a young girl, Muneeza Ahmad always enjoyed science and mathematics so when it was time for college, engineering seemed like the best fit.

“I like to solve problems and look at things from new perspectives.”

But Muneeza faced skepticism from her classmates about her decision to pursue engineering. Around the world, people still have a hard time picturing women when they hear the word “engineer.”

“They used to say girls were not cut out for engineering and will not contribute to the field in the future. But I had the support of my teachers and was able to convince them with my performance in the classroom and lab,” Muneeza says

SCHOLARSHIP PROVIDES LIFE-CHANGING OPPORTUNITY

Muneeza was working at a manufacturing supply firm in

Lahore when she heard about the Center for Advanced Study in Energy at NUST, but it was a long journey that involved saving enough money to pay the fees.

“I had been thinking about getting a master’s degree for some time but due to the financial burden of my siblings’ education, I couldn’t ask my parents to pay for me. I saved up for a year to cover the application fee, first-semester tuition fees and hostel rent for my master’s program. Fortunately, I was able to secure the USAID scholarship so I could focus on my education without having to worry about money.”

One of the goals of the USAID funded U.S.-Pakistan Centers for Advanced Studies in Energy is to provide scholarships for promising students like Muneeza and create the highly educated energy-sector workforce that Pakistan needs to address its energy shortages.

MAKING THE MOST OF THE EXCHANGE EXPERIENCE

Muneeza was part of the spring 2019 exchange cohort at Arizona State University (ASU). During the five-year life of the USPCAS-E project, over 200 Pakistani

faculty and students visited the United States to be part of a research and cultural exchange program at either ASU or Oregon State University (OSU).

Exchange scholars are assigned to faculty mentors and work on research projects in their lab for a semester in addition to entrepreneurship and policy classes, business and social etiquette, and cultural and industry visits. Exchange scholars have described their experience as transformational. It opens up horizons and doors, creating depth in cross-cultural competency, expanding professional networks and increasing technical knowledge and experience.

"The best part is getting to meet new people. ASU has a diverse student body and I have made friends from all over the world. They have helped me cope with the homesickness and made the experience unforgettable."

"I value the guidance I have received from my mentors and fellow students at the Energy Materials lab. They are always ready to help me out whenever I struggled with something. They are very passionate about what they do, and I am trying to incorporate this mindset in my work ethic as well."

The focus of the exchange visit is on energy-related research in one of the engineering labs but it's not all work and no play. During their time in the U.S., the exchange scholars have the opportunity to experience ASU culture and history through a variety of activities and excursions. One of the popular outings has been the Arizona Renaissance Festival.

"I had the best time at the Arizona Renaissance Festival because we got to revisit history through an immersive experience. There were so many interesting people selling their wares, providing entertainment and holding demonstrations at the event. I was not expecting the festival to be that huge with so many things to see and do."

So, what does she enjoy when she's not hard at work in the lab?

"I love being outdoors and my favorite activity is hiking or cycling. When I want to relax and de-stress I like to curl up with a good book and travel to fictional faraway lands using my imagination."

HARNESSING THE POWER OF THE SUN FOR ALL

In a place like Arizona where the sun shines almost every day, solar energy makes a lot of sense—but what about areas that do not get as much sunlight? Muneeza's research focuses on leveraging photovoltaics in diverse environments.

"We are designing a thermophotovoltaic cell that



USPCAS-E Scholar Muneeza Ahmad in Dr. Zachary Holman's lab at ASU.

converts heat into electricity. It will have a carbon heat source that emits thermal radiation which will be converted into electricity which means the device can run even when there is no sun. In theory, this will make it possible for areas that do not get a lot of sunlight to enjoy the benefits of photovoltaic technology. I am trying to find the best material for the anti-reflective coating so none of the incoming energy is wasted and all of it gets transmitted into the cell. I am using modeling software to design the structure and then verifying the results with the FTIR (Fourier-transform infrared spectroscopy) and spectrophotometer tools in the lab."

After graduating Muneeza plans to work in a research lab to gain more experience in the field of materials so that she can contribute to cutting-edge research. And after that?

"In five years, I will be near to completing my Ph.D. degree, inshaa'Allah [God willing]," Muneeza says.



Transformational Exchange Experience Sets Scholar on a Path to Lead

USPCAS-E scholar Asfandiyar Khalid is a people person. He likes to meet new people and have conversations with them.

"It opens up my mind and I learn a lot from them and try to share my thoughts with them," he says.

So, it's no surprise that he wants to make things better for others.

"I always had this intuition that I want to invent new things, innovate ideas and play a key role in the advancement of my country. I wanted to serve my country and make life easy for the common man of Pakistan," Asfandiyar explains.

He worked for the Khyber Pakhtunkhwa Economic Zones Development and Management Company. He worked on designing the distribution system within an economic zone as well as maintaining the grids and systems of the existing systems.

Asfandiyar is from Peshawar. He is currently enrolled in the Electrical Energy Systems Engineering (ESEE) program at U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E) at UET Peshawar.

He was in the final year of his bachelor's degree

program and serving as the president of the IEEE student organization at UET Peshawar when he learned about the USPCAS-E program.

"After seeing USPCAS-E's great standard of education, I enrolled in a master's degree program. I wished to be involved with USPCAS-E to try to help achieve its primary aim: solving the energy crisis in Pakistan."

Asfandiyar recently visited the United States as part of the USPCAS-E exchange program where he spent a semester working in Dr. Yang Weng's lab at Arizona State University. In addition to gaining intensive hands-on experience in the lab, he also learned about entrepreneurship, energy policy and U.S. culture.

"I always want to achieve excellence in whatever I do. This thirst for excellence has led to success many times in my life. An example of this is what I have achieved along with my colleagues here at ASU. We managed to build a prototype that will monitor the power flows from a solar PV system and this prototype is cheaper and remotely accessible, meaning I can monitor a system here at ASU back from Pakistan."

Asfandiyar knows that working toward a graduate degree and pursuing goals as an entrepreneur isn't easy.

"It wasn't easy to come this far; you have to struggle constantly," he says. "You have to overcome your fear of failure and also focus on success; that's the way to go to achieve great things."

Asfandiyar has a bit of advice to fellow students: "Stay thirsty for knowledge and try to quench that never-ending thirst, stay positive and committed towards



your goals and work hard to achieve them.”

When he’s not in the lab, he loves to read, mostly history as he feels that history always teaches great lessons for the future. He also loves traveling and exploring nature.

Asfandiyar’s favorite moments came during the spring break scholar excursion to various destinations in Arizona and California. He also enjoyed a visit to the Arizona Renaissance Festival.

“The best part of the exchange program was the people of the U.S. The cultural diversity was pretty amazing. I never felt away from home because people here are so loving and accepting.”

The exchange experience was transformational for Asfandiyar.

“I guess I will never be the same person that I was before coming here. I have a different view of this world now. This trip exposed me to a great environment; one that has completely reshaped my thinking. Rather than being a follower, I now want to be a leader. I want to be an entrepreneur, an innovator.”

And where does Asfandiyar see himself in the future?

After graduation, Asfandiyar wants to work for a government agency. He wants to use the expertise and knowledge he has gained from his exchange experience to help address Pakistan’s energy crisis.

He also wants to create his own startup company that would provide energy solutions as another way to benefit his people and his country.

“Five years from now I see myself as a successful entrepreneur who has made significant contributions in solving the issue of energy crisis in Pakistan. I see myself as an energy expert providing solutions to various energy problems.”





USPCAS-E Alumni Bringing knowledge home: USPCAS-E grads aim to spread lessons learned

Some visitors leave the U.S. with a miniature Statue of Liberty or Grand Canyon photos. USPCAS-E scholars leave the country with transformational knowledge they'll put to good use in their native Pakistan.

Two such scholars are Afshan Qamar and Farooq Umar. They've both earned master's degrees from NUST and established impressive research credentials. Now they're headed to doctorate-level study to further the expertise they will eventually apply to solving Pakistan's energy crisis.

SEEING THE BIGGER PICTURE

Both Qamar and Umar had degrees in electrical engineering when they were admitted to the USPCAS-E program, and both are firmly focused on developing renewable energy resources for their energy-strapped nation. Each clearly sees that the value of renewable energy extends beyond the electricity generated.

"I did my first job in electrical power stations," says Umar. As an electrical maintenance engineer at a utility, he was dismayed by what he saw streaming from conventional, coal-fired power plants: pollution. Nearby, however, he saw solar plants.

"I got really inspired by seeing that clean power. That is why I made my decision and quit my job."

Umar discovered the USPCAS-E program through a colleague from his undergraduate studies and applied.

"My friend was doing his master's," he says, "And his knowledge was very up-to-date. He had the latest technology to use with this program."

Qamar had been focused on renewables from her undergraduate days. While she values clean energy, she also recognizes the economic benefit that renewables deliver.

"Right now, the sources we use to create electricity in Pakistan are mostly oil and coal and, of course, they are very expensive," she says. "We're spending a huge amount from our economy on resources we're importing."

Renewables, she knows, can help stop that flow of money out of the country and also create trickle-down benefit.

"When you invest in renewables, you're not only creating electricity; you're creating jobs. A lot of people are involved: designers, manufacturers and the people who are installing these systems," she says.

OPENING A DOOR TO OPPORTUNITY

Participating in the USPCAS-E program put both Qamar and Umar at opportunity's door. As hoped, Umar found himself working in a well-equipped lab with top-tier technology, and he credits his experiences at Arizona State University with giving him the foundation to do one of the projects he's working on now: developing a smart solar inverter specifically designed to respond to the frequent load-shedding events Pakistanis endure. Load-shedding is when the electrical power supply is intentionally shut down to avoid excessive load. This disrupts power availability and everyday life. An inverter helps to keep certain devices running during load-shedding.

"It is very different from the inverters available in the local market," he says. "The number one benefit is that it has more efficiency."

That's because some inverters currently made in Pakistan can have efficiency as low as 20 percent, while 80 percent is the upper rating. Umar is designing an inverter he expects to deliver 90 percent efficiency, and it also can be run on-grid or off. That means the inverter can decouple from the grid, and load shedding can happen without necessitating curtailment of the solar generator or storage unit the inverter is attached to.

Along with gaining technical skills, Umar says his experience in the U.S. fostered personal growth, partly through the interaction with other professional researchers and partly through exposure to people of different backgrounds.

"ASU is a very diverse university. I went to an event, International Student Night, and there were people from 42 different countries. I have friends from India, the USA, China and Japan."

Qamar echoes these sentiments.

"The U.S. is the place where you have people from every country and every religion," she says. "That was a very good experience: seeing people with different cultures, behaviors, manners, religions and foods."

Like Umar, Qamar also values the experience she gained working in a world-class laboratory.

"The big thing for me is the experience I got at the Solar Reliability Lab at ASU," she says.

The center focuses on predicting the lifetime of solar photovoltaic (PV) modules for various climatic conditions by applying statistical tools. Qamar worked under the guidance of Dr. Govindasamy Tamizhmani (Dr. Mani), a PV research veteran at ASU with some 32 years of experience and more than 150 published papers.

One of Qamar's research projects during her USPCAS-E studies involved creating a mathematical

model that tracks the health of a PV system.

"You can see how your system behaved, how much energy you produced and compare that to how much energy you should produce," Qamar says. "The analysis gives you insights to help you install systems in different areas in Pakistan so that they can deliver maximum performance."

Qamar's other USPCAS-E project involved working on a micro-hydro system capable of generating electricity using the flow of small streams.

"The purpose was to electrify remote communities, especially in rural areas," she says.

Through her USPCAS-E research projects, Qamar was able to contribute to two professional papers, a good start to the publishing life that is central to an academic career.

WORKING TODAY AND WORKING TOWARD TOMORROW

Qamar is headed to graduate school again, hoping to be admitted to a university in Canada so she can explore another country. For now, she's teaching classes at two private universities in Pakistan. Once she completes her doctorate, she hopes to continue teaching in her native country and also consult within the energy industry there.

Umar is teaching as well, plus he's conducting research, including the solar inverter project noted before as well as the development of an AC motor test bed that is based on international standards to evaluate the efficiency of large industrial motors. The goal is to identify non-compliant and inefficient motors in the national grid.

Like Qamar, Umar is also headed back to North America, and he's awaiting word on admission to a doctorate program. He'll be attending a U.S. school on a Fulbright Scholarship, one of the most competitive and prestigious fellowship programs in the world. According to Umar, his USPCAS-E experience helped him earn that scholastic honor.

After he earns his doctorate, Umar dreams of enriching his hometown university, which he says now suffers from a lack of doctorate-level teaching fellows.

"I want to bring contracts, funding and good people," he says.

He also wants to encourage entrepreneurship locally in the energy sector. The similar path these two scholars have chosen to take reflects the life-changing knowledge they acquired through their USPCAS-E studies.

"It gives me my vision," Qamar says. "Now I am very clear on what I should do and what I will do. That is because of USPCAS-E."

BY BETSY LOEFF



This engineer put renewable energy knowledge to work

Some students earn a degree and work in their profession for a while before creating their own implementation. Not Amir Nangyal. He joined USPCAS-E at UET Peshawar and built his solar energy system after his first semester of study.

“My goal is to provide energy solutions and opportunities, research all industrial problems as much as I can and improve the industrial sector,” Amir explains.

Amir is from Yaruhussain, a village in the Swabi District, a district in the Mardan Division of Khyber Pakhtunkhwa province in Pakistan.

Growing up, energy crises were a fact of life for Amir. Power outages of up to 18 hours in the heat of summer were commonplace. He knew that he wanted to change the situation for himself and his country.

During his first semester, he learned how to design a PV system and then installed one in his home.

“I decided to be an engineer and find a solution to this problem. Alhamdulillah, for the last three years, I haven't faced load shedding because I installed a solar system in my house.”

Amir explains that Pakistan lacks expertise and access to technology in almost every field. And the energy sector is no exception.

“My wish is to teach everyone about designing their own system and doing power load management.”

Amir currently holds two positions. He's a project coordinator for the development of a 50MW solar power project in Dera Ismail Khan, or D.I. Khan, that is sponsored by FAS Energy (a subsidiary of the FawazAlhokair Group).

He's also a technical consultant with Baker Tilly Mehmood Idrees Qamar Chartered Accounts for the evaluation and ranking of pre-qualification documents submitted to Pakhtunkhwa Energy Development Organization for the development of hydropower projects conceived by independent power producers, or IPPs.

Before joining USPCAS-E, Amir worked as an assistant manager at Spinning Mill in Gadoon Amazai Industrial Estate, District Swabi, Khyber Pakhtunkhwa. He was looking for ways to improve his skills and education in the field of energy. He knew that he wanted to develop a PV system for his home to get rid of load shedding.

At USPCAS-E, he learned how to do just that. During his exchange visit to ASU in Spring 2016, Amir worked at the Photovoltaic Reliability Lab (PRL) at ASU. His exchange opportunity provided him with critical hands-on experience with a PV system.

"At the end of the training, we were masters of solar panels and PV systems because we performed different tests for claiming warranty of PV panel, factors affecting efficiency, factors affecting materials, defects in PV panels, and causes of failure of the PV system. Because of this knowledge and experience, I got the project coordinator job, and that has boosted my career," Amir explains.

During Amir's training at ASU, he learned how to make weather stations and worked with an MTT (mobile training tool kit), performing different experiments and designing the solar energy system. By installing weather stations, Amir explains, he can get real-time data in that location, and sharing this data can help IPP's in the development of their projects.

"I want to introduce MTTs in every engineering university/college to facilitate hands-on testing. Every student should be able to design a PV system for their own house to make the saying 'Every house is a powerhouse' true," says Amir.



Amir Nangyal, second from right, visited Intel during his exchange experience in Spring 2016.





Curiosity fuels this engineer's drive to realize a renewable energy future for Pakistan

Muhammad Ahsan Amjed is from Rajana, a small town in central Punjab in district Toba Tek Singh. He is currently a Ph.D. student at Ocean University of China (OUC) in Qingdao, China, where he studies energy and environmental engineering. Previously, he worked for the Pakistani oil and gas company Total Engineering Pvt. Ltd., where he worked on renewable energy technologies.

It was a long road to a Ph.D. program, but M. Ahsan says curiosity drove him to pursue engineering.

"My father was a mechanic, and I used to go to his workplace with my elder brother. When I was 12 years old, my brother and I started helping my father at his workshop. At that time, the economic situation of my family wasn't good."

It was hard work, but M. Ahsan was intrigued by the technology he saw in the shop.

"Technical stuff in the workshop always made me curious. I wanted to know more; like how an engine works, how it gets energy from fire, et cetera. My

curiosity pushed me to study engineering."

It wasn't easy because M. Ahsan's hometown lacked the educational opportunities that would ensure that he had the high marks needed to gain admission to engineering universities.

"Working with my father at the workshop, studying late at night, dealing with limited financial resources, being from an underprivileged area, and an overall lack of guidance made this journey difficult, but sometimes curiosity works positively to achieve dreams."

M. Ahsan credits his sisters and brothers for supporting him financially and academically to make his dreams possible.

DRIVEN TO ADDRESS ENERGY SHORTFALLS

For the last decade, Pakistan has faced serious energy challenges, and this has impeded economic development. M. Ahsan explains that the situation is more difficult in the countryside — places like his hometown. Energy shortages have disproportionately impacted small businesses and

industries, which, he explains, have, in turn, created a sharp surge in unemployment for millions of people.

"When I was about to graduate with my undergraduate degree, this was a hot issue in my country, and it changed my dream into a passion," M. Ahsan explains.

Just after graduation, he learned about a new energy research center with advanced facilities that were being developed by USAID. That caught his attention, and he decided to apply his passion to graduate studies at USPCAS-E at NUST.

Access to a better educational environment and research facilities boosted M. Ahsan's confidence. As an exchange scholar in the United States, he gained a new perspective on international energy policies and development. His research focused on energy security in Pakistan in the hydropower sector. He studies the ways that trans boundary water tensions can impact Pakistan's water, food, and energy sectors in the future.

"My research topic was a little unique from others: I worked on the water, food and energy nexus. The transboundary water division between India and Pakistan is always a hot topic on both sides of the border; it's an issue that could cause a war between two atomic powers if the dispute remains unresolved. Due to growing energy demands, both countries are constructing hydropower stations under limited water flow. My research was to estimate future water flows and power production under different scenarios by using a black box technique of artificial neural networking. My research helped me to understand the sensitivity of that issue better, and that will help in future project designs."

ENTREPRENEURIAL TRAINING KEY

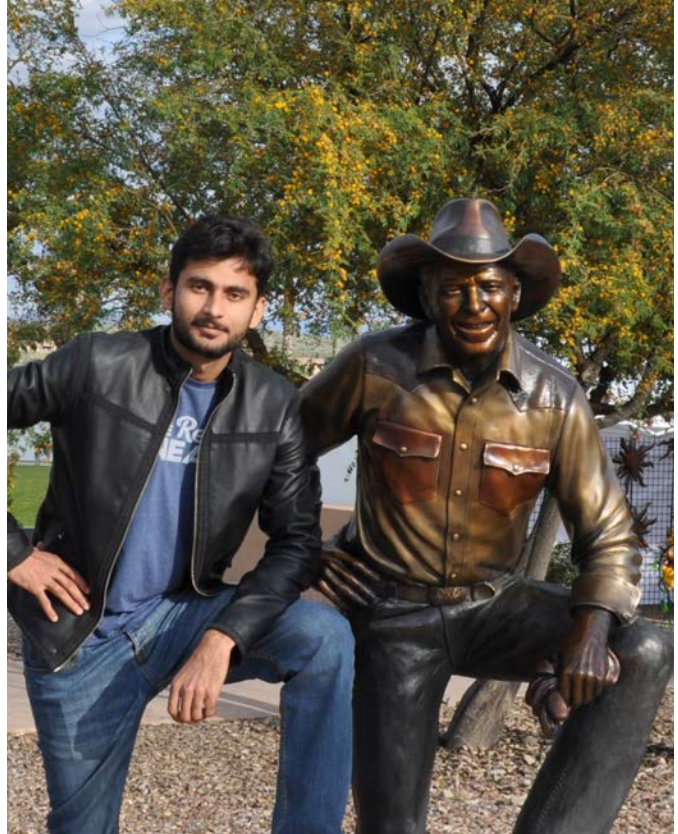
The entrepreneurial training he received via USPCAS-E was also critical.

"Entrepreneurship training encourages lots of young scholars to start their own businesses in the energy sector. That's what I'm thinking of for the future, too."

M. Ahsan hopes that multidisciplinary knowledge and research on renewable energy will help him to create his own business in Pakistan's energy sector. He knows that the world is moving towards sustainable, clean sources of energy, so his main focus is to target the emerging markets in developing countries like his native Pakistan.

M. Ahsan says it will be an honor to be the first Ph.D. graduate in his hometown.

"Whenever I look back on my life, it seems impossible that I should be here, but my internal curiosity and continuous dissatisfaction with the status quo brought me to this point."



M. Ahsan Amjed was an exchange scholar at ASU as part of the Spring 2017 cohort. He's now pursuing a Ph.D. at Ocean University of China in Qingdao, China.



M. Ahsan knows that many young scholars have benefitted from the USPCAS-E program and that these benefits extend beyond each individual to their families and communities, and Pakistan as a whole.

"I would like to say thanks to USAID and USPCAS-E for supporting me at every stage and making this dream possible. It's not just the story of one person; it's the story of one family and one underprivileged small town. Most importantly, it enhanced the mutual relationship of two countries (USA and Pakistan) at a public level and helps Pakistan, from the grassroots level to higher government levels, to mitigate energy challenges."



Following her heart to a sustainable energy future

Even as a toddler, Maham Akhlaq's father had big dreams for her and her older sister.

"It was my father's dream to see my sister become a doctor and for me to become an engineer," she explains.

Akhlaq, who is from Lahore, completed her master's degree in Energy Systems Engineering at USPCAS-E NUST in 2018. Currently, she is a lecturer at Government College University Lahore. She also works as a research associate in a lab in GC University's Physics department. There, she is working on advanced materials and their applications in electronics.

Akhlaq's father passed away when she was only two years old, but his dream became her dream. And her mother's hard work and dedication kept Akhlaq on the path to engineering. Even as a child, she wanted to understand why things happened. She remembers receiving an accidental electric

shock as a child, and that immediately, she wanted to understand what had happened and why.

"When I was five years old, I suffered from an electric shock while plugging in a television. For an instant, I thought, 'What was this shock, really? Why did this happen only when we plugged it in? Why did I get an electric shock?' That was probably the beginning of my fascination with electronics."

In June 2010, when Akhlaq was still in high school (FSC), there was a 12-hour electrical outage.

"Even in Lahore, one of the most populated cities in Pakistan, we still faced this much load shedding. Around that time, my mother suffered a fracture. Due to the summer heat and load shedding, she was unable to get proper rest, and her recovery was slow."

Akhlaq realized that there were many other people in Pakistan in poor health who were suffering from this massive power outage. She knew that she had to do something about it.

"I thought that as a young person in a developing country, it is my responsibility to address these issues. This energy crisis can only be reduced by relying on clean energy technologies."

When she was in the final year of her bachelor's degree program, she studied solid-state electronics as an elective course. It was the course that ignited her interest in solar energy generation and solar panels.

One of my classmates told me about a new energy center at NUST that was working on introducing energy-related solutions to address the growing energy crisis in Pakistan.

She decided to join USPCAS-E as a graduate research scholar. As part of her studies, she applied to the exchange program that would send her to study and do research in a U.S. university lab for a semester. The opportunity proved to be transformational.

"I was sent to Arizona State University during my research semester. The exchange program contributed immensely to my academic growth as well as personal growth."

Akhlaq was assigned to the Energy Materials Lab under the supervision of Dr. Zachary Holman. The work there involved finding highly innovative, efficient, and cost-effective solar energy-related solutions.

"I worked with Dr. Holman and one of his doctoral students on heterojunction silicon-based solar cells, which are considered to be the future of solar cell technology. Everyone from Dr. Holman's research group was always ready to assist me; they never made me feel like we were interns who were there for just a semester."

Apart from academics and research, Akhlaq says that the exchange program was an excellent opportunity to meet people from different cultures who are working together toward a common goal.

"The work ethic and dedication towards their work really amazed me. The research project was based on the synthesis of a novel nanostructure for solar energy applications. I learned to use newly installed equipment for nanostructure synthesis. It took almost 5-6 months with continuous patience and determination to fabricate my required material. For me, my research experience showed me not only the benefits of pursuing a career in academia, but it also taught me how to stay persistent and dedicated to all of my goals."

Her research was based on advanced generation solar cells. These cells are small in structure but provide high efficiency and are low in cost. These low-cost solar cells can be especially beneficial in a country with financial issues.

Five years from now, Akhlaq sees herself as a Ph.D. researcher in an academic setting working on introducing energy-related degrees and courses that inspire Pakistani youth to work in renewable energy.



In addition to her love for engineering, Akhlaq loves photography. She especially loves capturing sunrises and sunsets: these remind her how beautiful and amazing nature is. A self-described bookworm, she also gets inspiration from other people through their stories.

"I love reading biographies to get inspiration from other people's lives. I love reading Paulo Coelho, for example."

She explains that the central theme of Coelho's book, *The Alchemist*, is to pursue your dreams by following what your heart desires.

"This is my inspiration to reach my goals."



Single-minded focus drives this engineer toward a renewable future

NOMAN KHAN HAS A SINGLE-MINDED FOCUS WHEN IT COMES TO CLEAN ENERGY: "IT'S SIMPLE: WE NEED CLEAN ENERGY"

He wants all of his friends and colleagues to stay focused, professional, and single-minded about the future of Pakistan. He believes that to make a difference, they must learn and create, invest time and money, make sacrifices, and build everything from scratch.

"We must explore innovative ideas, new research, and new technologies to get out of the vicious circle that an energy crisis creates. We have inherited a broken system, and we must rise up to the task and rid Pakistan of energy crises."

Noman is from Swabi in the Khyber Pakhtunkhwa province. Noman earned his master's degree in materials for energy storage and conversion from USPCAS-E at UET Peshawar. He is currently working as an assistant director in the Pakistan Civil Aviation Authority, which is akin to the Federal Aviation Administration (FAA) in the United States.

He hopes to continue his research but says he is currently preoccupied with his job, so it's hard to focus on academics and research. But he is learning more entrepreneurial skills inspired by Ken Mulligan, the instructor at ASU, who has taught entrepreneurship to the USPCAS-E visiting scholars.

"I see myself as not just a researcher but also someone who puts my research into practice and sells it. Research and development are key to tackling our energy problems.

Educating the people, bringing more people to this field, and then creating a critical mass of researchers who can then join forces will also be crucial."

Noman also wants to establish a small think tank of fellows to discuss energy and ideas along with social and economic issues.

"It's also my dream to establish a 'freestyle' school and teach science interestingly and innovatively and encourage creativity, free-thinking, participation, initiative and leadership."

"For Pakistan to make progress, I have a simple formula: we need more billionaires, more Nobel Prizes, more Academy Awards, more Olympic gold medals. I will work to achieve this end in one way or another."

Noman had an engineering mindset from a very young age.

"Engineering was fascinating to me right from the beginning of my school days. My dad purchased a Pentium-II computer during my mid-school years, and I was fascinated with what it was capable of. I would read articles in Microsoft Encarta Encyclopedia, and that was a time when the internet was virtually non-existent in Pakistan. I would spend hours reading articles on science, and that really shaped my future course for the years to come," he recalls.

This put him a class all his own, and he admits, "I gave a hard time to my science teachers because I could read more about my subjects than they could."

But the path was not a smooth one for Noman.

His family endured personal tragedies and financial crises. He was able to continue his studies through hard-earned scholarships.

Today he sees that hard work has paid off in the end.

“Engineering has not only changed me and my life for the better, but it has also changed our collective lives in this country. Our standard of living is many times better than it was a decade ago,” Noman explains.

Noman is still an avid learner, not just in engineering but in other sciences as well, including renewable energy, astronomy and astrophysics.

Noman explains: “It makes me more pragmatic, empowered and non-superstitious. The scientific mindset is a great gift, and one should strive hard to achieve it.”

Noman was drawn to study engineering as a result of his personal experiences with energy shortages, shortages that dominated his life. It made it easy for him to choose a course of studies—he knew that he wanted to fix the electricity shortage that loomed over his life—and negatively impacted his country and its economic prospects.

He explained, “Pakistan’s energy problems had made our lives miserable for a very long time. We were mostly up at nights, frying in the scorching heat of summer, and it was literally a part of every discussion.

And I always hoped that someday I’d be able to do something about it.”

Then came along USPCAS-E and rest, as they say, is history. Noman was in the final year of his undergraduate studies at UET Peshawar when USPCAS-E was established. The new center conducted seminars and workshops and encouraged students to look into programs being offered. Noman says he didn’t think twice.

“My cohort was the first batch in the energy materials program. And it was the start of a great learning journey that I will always cherish.”

Noman participated in the exchange program at ASU in Fall 2016.

“I worked on proton exchange membrane fuel cells during my ASU exchange program. With my colleagues, I developed a new catalyst for proton exchange membrane fuel cells that could lead to better fuel cell performance and lower the cost at the same time. I also published a paper on the same topic.”

USPCAS-E was a life-changing experience for Noman. Not only did he learn engineering, but he also gained other things that he believes are perhaps more important. His experience with friends and colleagues in the U.S. significantly changed his thinking process.



“I worked with world-class faculty and also in a setting that was highly professional and innovative too. The cultural experience, international exposure to peoples from all parts of the world, was an absolute blessing. I have a very different (and more accurate) worldview now than I did a few years ago.

“As an exchange scholar, I visited many places that I dreamed of visiting. I learned about the American way of life, including their politics, education, cities, energy systems, and so much more. USPCAS-E is a great idea, and it will shape Pakistan’s energy future in the years to come. The young men and women equipped with this knowledge will make a huge difference in my country.”

“The most important aspect of my research was the simple realization that to solve our extraordinary energy problems (and associated problems), we will have to come up with extraordinary solutions.”

He believes that climate change, in particular, has totally changed how future energy systems should look. He thinks fuel cells show a lot of promise, using hydrogen to electrochemically produce electricity without also producing carbon dioxide is exciting.

“For me, the fuel cell was ‘love at first sight’ because it is so simple yet a lot more promising than any other energy system, and one day, it will, in one way or another, change the world.”

He concedes that we are a long way from that future and that more investment and research are needed to address materials and cost challenges that limit fuel cell development.



Building a Network of Energy Engineers for Pakistan's Future

Sara Sultan has come a long way from Haripur, Pakistan: 11,865 kilometers or 7,372 miles to be exact. The former USPCAS-E scholar from NUST is currently pursuing a Ph.D. in Energy Science and Engineering (with an entrepreneurship minor) at the University of Tennessee, Knoxville. As part of her studies, she works at Oak Ridge National Laboratory (ORNL) in the Building Science Division. She's also enrolled in a concurrent master's degree program in the Mechanical Engineering Department.

Something immediately apparent is that Sara is busy. She is on a mission to improve energy efficiency and to create opportunity and connection for students in Pakistan.

"I'm an executive member of the Environment and Sustainability Committee of the Student Government Association at my university and also founder and president of the Pakistan Students Association."

Sara is also committed to helping other students seeking to study in the United States.

"I'm a mentor with an organization based in Pakistan that helps students with the U.S. admissions process and applying for Fulbright scholarships."

She's also connecting USPCAS-E students and alumni from NUST.

"I also founded the USPCAS-E NUST Society to bring all the students and alumni together and guide each other for both

professional growth and personal skill development. I have been leading some advisory sessions on research, technical writing, communication skills, and higher education and scholarships."

Sara knew she wanted to be an engineer from a very young age. It turns out that she had a passion for an engineering discipline without knowing what it was called: mechanical engineering.

"I hail from a small village in Khyber Pakhtunkhwa province, where females are not supposed to pursue higher education—especially for STEM degrees. There was always a misconception that engineering is not for girls."

Many girls face limited educational resources and a non-supportive family environment, but Sara's family was different.

"I feel proud to have supportive parents who let me break all these stereotypes."

Sara is trying to raise awareness about renewable energy and encourage everyone to do what they can on a personal level to adopt behaviors that increase energy conservation and efficiency in homes.

"I delivered some awareness-raising seminars to promote renewable energy research at universities in Pakistan, especially the ones in underdeveloped areas. I served as a volunteer instructor at two universities in my city to promote energy engineering and to encourage students to pursue research in energy."

Sara loves to share her journey to energy engineering.

"During my bachelor's program, I used to ponder my research career and would say to myself, 'It should be something that will solve one of Pakistan's biggest issues.'"

But the specifics were unclear to her until she took an energy course online via edX offered by Delft University of Technology (TU Delft).

"It inspired me to search all of the graduate programs in energy at NUST, which was my dream school in Pakistan. I wrote a statement of interest, did the interview, and got into the Energy Systems Engineering program."

Sara visited Oregon State University as a USPCAS-E exchange scholar in fall 2016 and worked on a hydropower project. The project had two parts: data analysis to assess the hydropower potential in Pakistan and an evaluation of the efficiency of a pico hydropower system (for power generation of under 5 kW) with an AC generator and an impulse turbine. In addition to contributing to the group's efforts, Sara also designed the system for a cross-flow turbine.

"I took many research design and methodology seminars, communication skills development sessions and interdisciplinary workshops at the library and in different departments at OSU, all of which helped me a lot during my thesis phase," she explains. "I'm an explorer, a dreamer, and always open to learning and improving myself, taking any criticism positively. The experience with the USPCAS-E exchange program was significant in all aspects, from research to personal development."

Sara says that she explored a new culture, but most importantly, she says she realized her true potential and discovered her ability to make independent decisions, even under society's influence and with financial pressures.

Sara has worked in the areas of water desalination, solar power, and hydropower and wanted to combine

aspects of all three in her work.

"I decided to work on energy-efficient buildings with sustainable thermal energy storage. Incorporating small-scale renewable energy systems to replace fossil fuels and shifting the energy load from peak hours provides a solution with economic and environmental benefits."

Sara is also working on developing an energy consumption policy for residential buildings in the U.S.

"I want people to adopt energy-efficient behaviors and incorporate renewables in their homes, not just for the environment, but for themselves. Start with saving energy and reducing utility costs," she says.

Where does Sara see herself in the future?

"I see myself as an influential energy entrepreneur, a well-known energy researcher, and an ambassador of U.S.-Pakistan cultural exchange. I hope to conduct some innovative research and take a lead role in ORNL's innovation crossroads program by converting my research into a successful entrepreneurial venture. I also see our USPCAS-E NUST Society growing into a big collaborative effort between our alumni and students in Pakistan."

Sara hopes that in the near future, the USPCAS-E scholars will be able to create more awareness about energy and higher education in Pakistan, an awareness that will eventually lead to more energy enthusiasts, researchers, entrepreneurs and policymakers.

In addition to researcher and mentor, Sara is also an artist, a traveler, and a writer. Sara wants people to look beyond stereotypes to see women as multifaceted, complex individuals, who are ready to make things happen. She also wants people to know that she is prepared to tackle

anything, even the impossible.

"I'm always misinterpreted as a delicate emotional girl and judged by a stereotype that says women can't do great things like men. I think there's much more to women and especially to me. I don't go by 'this is not possible' instead of by 'if no one has been able to do this, this is definitely my chance to become a pioneer.'"

Sara wants to inspire people and help them find ways to utilize their true potential.

"I believe that individual and personal growth is critical to creating a strong society, and that's my strength."

Sara applied to the Fulbright program, but she felt that the local interview panel had concerns about her hijab and she later received a rejection letter. It was a demoralizing and disappointing experience. Sara thought that she would need a Fulbright to pursue a Ph.D. in the United States and couldn't see another path forward. But then she applied to an interdisciplinary program offered through the Bredesen Center at the University of Tennessee, Knoxville. She was accepted and received a DOE fellowship and a chance to work at one of the most prestigious energy labs in the United States. Her message to fellow students who are navigating the application process: persevere and believe in yourself.

"I never give up and never stop believing in myself. I think it helps me dealing with stress and moving on from failures. So, I believe, what happens, happens for the best"



This start-up founder wants to help her fellow Pakistanis realize their full potential

Samia Subhan Qureshi is committed to finding efficient energy solutions for her country so that everyone can realize their full potential.

Samia is from Bannu in the Bannu District in southern Khyber Pakhtunkhwa. She currently lives in Peshawar where she is pursuing a master's degree in the USPCAS-E Electrical Energy Systems Engineering program at the University of Engineering and Technology (UET) Peshawar. She learned about USPCAS-E while pursuing her bachelor's degree at UET Peshawar after attending a workshop organized by USPCAS-E.

Samia was part of the last cohort of USPCAS-E exchange scholars to visit the U.S. in spring 2019. She conducted her research at ASU's Photovoltaic Reliability Lab (PRL-ASU).

When asked to describe the importance of her research, Samia explained: "According to Dr. Govindasamy Tamizhmani (founder of PRL-ASU), if the concept that I used in my research is implemented in real-time calculations, it will change the solar photovoltaic industry."

She says that by eliminating the use of pyranometers, pyrhemometers and two-axis trackers for outdoor

angle of incidence (AOI) measurement, their proposed model offers a cost effective outdoor AOI measurement. This new method combines attributes of older models through an AOI correction model that accounts for direct as well as diffuse light.

Samia is also one of the founders of a solar startup, the GreenWend Company.

"I want to promote clean energy solutions in my country. On the way back to Pakistan from the U.S., I realized that my passion for contributing some benefit to society and playing a positive role had increased. Because of my exchange experience, I realized that if you don't get your basic needs met, you might survive, but will not live your life in a meaningful way. Many people are suffering from power outages and load shedding and they can neither run their businesses in a proper way nor light up their homes."

During her exchange experience, Samia participated in entrepreneurship training. Entrepreneurship instructor Ken Mulligan tells the exchange scholars that Pakistan needs to move beyond being a nation of job seekers to become a nation of job creators, advice that Samia took to heart.

"After my arrival back to Pakistan in May 2019, I thought that if I just sat and waited for a job then I would become a part of a problem. Instead I decided that I should take the initiative and become a part of a solution!"

She started GreenWend with other energy engineers. She says that her USPCAS-E experiences played an important role in enabling her to think like an entrepreneur.

Samia also completed an internship at PTCL Peshawar, a telecommunications company, where she worked in the switching center.

From a very young age, Samia says that she "loved to play with equations." She explains, "My favorite subject was mathematics and I always succeeded in getting the highest grade."

Growing up, she realized that many people didn't consider women for technical or field work.

"I wanted to break this stereotype. My family gave me an open choice for selecting any field and luckily, I am the first female engineer of my family. I always find it fun working in the field."

Samia noticed many small differences between Pakistan and the U.S. during her exchange experience but she also realized the potential in her home country.

"I just felt that if they can be so much ahead in technologies, then why can't we? There is no difference between people when they are born. It's just that how they utilize their energy. Without proper management, nothing can be successful."

During her exchange visit in the U.S., Samia lost her mom. Samia beautifully describes mothers as "the precious gem in every human being's life."

She said her father was her biggest supporter during this difficult time.

"It was really a hard time for me being away from my family. But my father was my greatest supporter, as always. He encouraged me to complete my research at ASU and guided me to make every decision calmly. I learned that if God gives us hard times, He also gives us power to get through the situation."

Samia also expressed gratitude for the support from her fiancé, Zeeshan Saeed Shah, a USPCAS-E scholar from the spring 2018 cohort who offered guidance on selecting a lab and strategies for their startup.

Five years from now, Samia hopes to see her start-up among the top companies of Pakistan. She says acknowledges that there are initial challenges with startups and sometimes big risks, but she is ready for the challenge.

"I strongly believe that hard work will always pay off," she explains.





Growing up off-grid inspired this engineer to improve access to energy and energy-related employment

As a child, Zeeshan Saeed Shah says that he was always curious and interested in math and science. He represented his school in exam competitions.

"I used to think a lot about electric circuits and electron motions which drew me towards engineering. As I got older, I was drawn to electronics and other electric stuff."

But electricity is in short supply in his hometown of Bannu in the Bannu District in southern Khyber Pakhtunkhwa.

"I completed my higher secondary education in Bannu, where we were barely able to light our homes for an hour in a day. Places like my hometown are considered to be off-grid areas, and the lack of energy access directly impacts education and business."

This first-hand experience with severe energy shortages and an overall lack of energy availability shaped Zeeshan Saeed's future. As an undergraduate student at the University of Engineering and Technology (UET) Peshawar, Zeeshan Saeed saw some posters about an upcoming workshop arranged by USPCAS-E. After attending that workshop, he wanted to join the center.

He is now pursuing a master's in the USPCAS-E Electrical Energy Systems Engineering program at UET Peshawar.

At USPCAS-E, Zeeshan Saeed learned about renewable energy, specifically solar power, a clean source of energy that is environmentally friendly.

Zeeshan Saeed visited Arizona State University as part of the fifth cohort of exchange scholars in



spring 2018. During his exchange training, Zeeshan Saeed conducted research in the power electronics lab under the supervision of ASU Professor Bertan Bakkaloglu. He was the team leader and worked on analyzing fundamental characteristics of inverters for a photovoltaic system. He also interned with the "Defend Our Future" club which arranged workshops on recycling and exploring different ideas on how to clean up the environment.

Zeeshan Saeed says he considers himself lucky to have been a USPCAS-E student.

"The most important experience was my exchange visit to Arizona State University. I spent my time in a research laboratory where I learned research skills and technical skills. During my internship at the Defend Our Future club, I learned management and marketing skills."

As an exchange scholar, Zeeshan Saeed also took classes in energy policy and entrepreneurship, experiences that changed his trajectory.

"We had a lot of fun in the energy policy class where we worked on designing policy for the energy sector of Pakistan. I met some great entrepreneurs through our entrepreneurship class, and we learned how to articulate an idea and how to present it. This class drew me towards entrepreneurship."

His research became a building block of his future work in GreenWend, a startup he launched with colleagues that will provide solar services in both the private and government sectors. Its mission is to decrease electricity costs, eliminate load shedding, and provide employment and training opportunities.



"We hired around 15 employees, including engineers, managers and technicians. In 2020, we are arranging seminars and workshops in schools, colleges and universities to promote solar energy in Khyber Pakhtunkhwa including newly merged areas."

"At ASU, I was working in a group project where we analyzed the fundamental characteristics of an inverter for a photovoltaic system. We also studied practical approaches for a Maximum Power Point Tracking (MPPT) system and the modeling and characterization of MPPT-based boost converters. I used the same MPPT techniques in my final year project which was about photovoltaic efficiency improvement. Now, we are using practically the same approach in our startup."

When Zeeshan Saeed thinks about the future, he starts with the present, working on the GreenWend startup. In two years, his goal is to provide at least 20MW solar power in the private and public sectors and provide employment for more than 100 engineers and technicians in all districts of

Khyber Pakhtunkhwa and newly merged areas.

"I want to train people through seminars and workshops and steer them towards green energy. After two years, I plan to launch another startup, currently in the feasibility planning stage, which will bring more employment all over Pakistan."

When asked what most people don't know about him, Zeeshan Saeed said simply, "My capabilities." He explained that opportunity is created not granted and that your success doesn't depend on your location or environment.

"A person living in Bannu can become the next Bill Gates or Mark Zuckerberg if he or she utilizes time and energy the way they do."

Zeeshan Saeed encourages others not to take the easy route with a job and instead to become a value creator as an entrepreneur.

"Together we can contribute to society, and we together can bring happiness."



USPCAS-E Technology Centers set to leverage Pakistan's enormous solar potential through photovoltaic testing and certification services

THE TECHNOLOGY CENTERS AIM TO BE THE DOMINANT PLAYER IN THE SOLAR ENERGY TRAINING MARKET

The U.S.-Pakistan Centers for Advanced Studies in Energy at the National University of Sciences and Technology (NUST) and University of Engineering and Technology Peshawar (UET) have realized significant accomplishments in the past five years including nearly 900 enrolled students, the development of 14 new degree programs, many new courses, ongoing stakeholder engagement, and more than 200 graduates. Financial sustainability is key to maintaining this momentum of the centers at NUST and UET Peshawar.

By addressing critical energy sector needs, the centers can position themselves as significant training partners for individuals and businesses throughout Pakistan.

Pakistan's solar industry is facing a huge skills gap

and requires experienced workers who can ensure customer satisfaction through quality design and installations. According to the "Value Chain Analysis of Solar PV in Pakistan" report by the German Solar Energy Association and GIZ Pakistan, the country has enormous photovoltaic (PV) potential, and it has all the necessary conditions for its development and implementation. However, there is a lack of specific knowledge and expertise relating to PV in the workforce. Currently, there are no accredited facilities that offer solar PV training. Although the Technical Education and Vocational Training Authority (TEVTA) provides training to students, these are solar energy-specific opportunities.

USPCAS-E at NUST and UET Peshawar are partnering with Arizona State University (ASU) to create Technology Centers to address this gap. These centers will train students and energy sector professionals in Pakistan. The goals: provide solar photovoltaic related research, certification testing,

consulting and educational services for individuals as well as for private and public sector organizations in Pakistan.

In particular, the primary certification services to be provided are performance and qualification testing of PV modules according to IEC 61215 standards, engineering and design evaluation of PV modules and systems, workforce skills and competency training on the design, installation, and operations and maintenance of PV systems.

Dr. Govindasamy “Mani” Tamizhmani, director of the Photovoltaic Reliability Laboratory at ASU explains: “Currently more than 90% of solar PV modules in Pakistan are being imported, many of which are sub-standard quality. My vision for both technology centers is to become nationally recognized and internationally accredited ‘centers of excellence’ on solar photovoltaic technologies, components and systems.”

The Technology Center training programs began in July 2019 and are designed to be immediately applicable, enabling students and professionals to put their new skills to work directly.

Both technology centers are equipped with unique, state-of-the-art tools and equipment to enable offering the services mentioned above. These centers and their equipment can also be leveraged for research and teaching purposes by faculty and students at NUST and UET Peshawar.

ADDRESSING MARKET NEEDS

The Technology Center trainings are specifically designed to attract individuals who are looking to start a new solar business or want to gain or upgrade solar power-focused skills. The target market includes individuals from a variety of positions and backgrounds: inspectors, managers, supervisors, technicians and engineers working in industries, businesses and government agencies. Current students and recent college graduates are also primary target demographics, from new science and engineering graduates to BTECH and DAE students looking to leverage their skills and knowledge in the solar job market.

The competitive advantage of the Technology Centers are the structural relationships with NUST and UET Peshawar, two well-known and respected universities in Pakistan. This relationship aids in name recognition and the marketing of their programs to potential clients throughout Pakistan.

The Technology Centers will provide certified and accredited training in a gender-inclusive learning environment. A hands-on approach will facilitate an applied learning environment fully equipped with the



latest equipment and technologies. In the absence of viable alternatives in Pakistan, NUST and UET Peshawar have the unique opportunity to leverage the significant investments, human capacity and equipment in the creation of the technology centers.

This is part of the effort to increase the brand recognition of USPCAS-E in Pakistan through attractive and market required skills, research, product and system services.

TRAIN-THE-TRAINER APPROACH

Arizona State University conducted a five-day train-the-trainer workshop at NUST for faculty and representatives of the solar PV industry. Each trainee learned to deliver training programs that provide vocational proficiency in the application, design, installation and operation of residential and commercial solar PV systems. They also learned how to conduct PV power plant surveys, how to identify potential material, safety and performance-related issues, and how to conduct analyses on the impact of these issues on long-term energy production for solar PV power plants in Pakistan.

Bülent Bicer, project manager at the Photovoltaic Reliability Laboratory at ASU and the instructor of the workshop explained: “A successful market penetration of renewable energy systems requires an enabling policy framework, high-quality products and a skilled and competent workforce. The focus of this train-the-trainer workshop was to provide internationally accepted best practices and skills in the design, installation and operations of solar PV energy systems in Pakistan. Each trainee was provided with all training materials with the expectation to further disseminate the learned knowledge to professionals, technicians and students through short programs and courses.”

The five-day training focused on the fundamentals, design, installation and operations of PV energy systems based on international best practices, such as those promoted by the North American Board of Certified Energy Practitioners (NABCEP).

Both NUST and UET Peshawar are committing classroom and lab resources as well as key personnel. USPCAS-E NUST and USPCAS-E UET Peshawar have dedicated space to host training and lectures. The Technology Center personnel will offer short technical training programs. At NUST, the key personnel for the Technology Center are faculty member Dr. Hassan Abdullah Khalid and staff member Mudassir Ayub. At UET Peshawar, the key personnel are Assistant Professor M. Arif Khattak, Technology Center Lead Muhammad Arif, Industrial Liaison Manager Ms. Shaista Afridi, and Lab Engineer Ms. Noor Saif.

These staff members visited ASU for hands-on training at the Photovoltaic Reliability Laboratory at ASU's Polytechnic Campus, a lab headed by Govindasamy "Mani" Tamizhmani. The three-week training at ASU-PRL (ASU Photovoltaic Reliability Lab) focused on providing the technology center staff from NUST and UET Peshawar, with the fundamental knowledge of conducting PV module qualification testing activities required by the IEC 61215 standard.

Noor Saif from UET Peshawar said, "My training focused on laboratory-based testing, both indoor and outdoor. This particular activity experience greatly benefitted me in understanding what actual results can be achieved under real-time testing conditions along with the fact that what external or internal factors could hinder or favor our test results. I learned about all the quality tests that are performed under IEC 161215 and most importantly I had open access to all the latest equipment that are used in the lab and the safety procedures that we shall adopt while doing a test. I got the idea of how we are going to establish our lab in Pakistan and what else we needed in terms of equipment, area, logistics, human resources, and safety measures."

Arif Khattak from UET Peshawar said, "The training provided a model of how to establish and run the technology center at UET Peshawar. ASU provided major help in selection and procurement of the most relevant equipment."

The Technology Centers will also focus on continuous program assessment to provide the highest quality training and services. Continuous improvement efforts will include ongoing monitoring and feedback collection so the centers can determine what's working – and what's not – to adjust the offerings to meet market needs.

THE TECHNOLOGY CENTERS AT A GLANCE:

OBJECTIVE	Provide solar PV training to individuals in the public and private sector
PRODUCTS/SERVICES	<ul style="list-style-type: none"> ▪ Certified Solar PV Training ▪ Solar pumping ▪ Planning, construction and management of micro hydro ▪ Energy efficiency and conservation in buildings and industries ▪ Solar business and sales
POTENTIAL CUSTOMERS	<ul style="list-style-type: none"> ▪ Master's students ▪ Science and engineering graduates ▪ BTECH/DAE students ▪ Managers, supervisors, technicians ▪ Private sector and government employees
POSITIONING	<ul style="list-style-type: none"> ▪ Certified and accredited trainings ▪ Hands-on approach ▪ Highly trained professionals ▪ Excellent learning environment ▪ Gender-inclusive learning environment ▪ Inclusive learning environment open to men and women

ENSURING THE LONG-TERM SUSTAINABILITY OF THE CENTERS FOR ADVANCED STUDIES IN ENERGY AT NUST AND UET PESHAWAR

The technology centers provide dedicated value-add services to the public and private sector in Pakistan on solar photovoltaic related technologies. The services to the public sector would include training the trainers and technicians for university graduates and technical school graduates; technical assistance to government procurements during tender processes and international product import processes; and independent evaluations of PV power plants maintained and operated by public entities. The services to the private sector would include product certification testing, engineering testing of products and systems, independent EPC (Engineering Procurement and Construction) evaluations, and O&M (Operations and Maintenance) evaluations. These services will be promoted and marketed in line with country-specific climatic conditions and pricing. The generated revenue will enable the centers to become financially self-sufficient after a short period. Interaction with the private industry and public organizations is crucial for the long-term success and sustainability of both centers. For this reason, NUST and UET Peshawar have assigned dedicated individuals for outreach/marketing activities.

Hassan Abdullah Khalid from NUST explained, "Such a facility will generate revenue by not only providing PV module testing and certifications but also providing additional consultancy and engineering evaluation services to the local industry/PV plants in Pakistan."





USPCAS-E scholars visit Neelum-Jhelum Hydroproject

The U.S.-Pakistan Centers for Advanced Studies in Energy arranged an industrial visit for MS Energy Management and Sustainability students to Neelum-Jhelum Hydropower project in Kashmir on October 25, 2018. The purpose of this visit was to enhance industry exposure of the scholars and experience real-world power project implementation and management techniques. The project has an installed capacity of 969MW electricity and achieved maximum generation in summer 2018.

"There is a misconception that this project is a failure due to the prolonged completion time and increasing costs, but our visit here was an eye-opener. I came to know about the actual facts and figures. The project is no doubt costly but still can be profitable

due to useful life and number of sufficient electricity units produced annually," said Danish Shahzad.

On site, the students were briefed by the project engineer about different phases of implementation. This plant is a run-of-the river project with no storage and minimum wastage in both the rivers, Neelum and Jhelum. Water from the river is diverted to a tunnel that is under the mountains, over 60 km in total length. Initially, only a single tunnel was planned but later, modifications to the plan resulted in two bifurcated tunnels because the weight of the mountain could crash it. Also, two spillways and a buffer zone with rock fills over fault lines were built as a protection shield against earthquake. The powerhouse is located downstream, underground where the water from both rivers is combined to run the underground MW Francis turbines.

"The industrial visits is a good initiative by USPCAS-E. Not many programs offer this support to students. This visit helped me integrate theoretical knowledge with practical scenario. I also got some ideas of research topics that I plan to work on" says another student Syed Faisal Shah.

Good for Youth, Good for Pakistan

The United States Agency for International Development (USAID) launched a mass media campaign, “Good for Youth, Good for Pakistan”, to celebrate accomplishments of inspiring young Pakistanis who have achieved personal successes as a result of partnership and support from USAID projects across the country. This campaign is providing a platform for youngsters to discuss the challenges they are facing and how they can play an active role in proposing solutions.

As part of this national initiative for Pakistani youth, a TV program on Khyber News featured USPCAS-E scholars who took the stage as panelists and shared how they are making a difference in their communities. The program, mainly in Pushto and Urdu language, focused on issues related to education, healthcare, jobs, energy, clean water, and gender equality. Khyber TV show went on air November 17, 2018.

One of the USPCAS-E exchange scholar, Aemal Ahmed, received best speaker award from USAID at this TV show. It is also worth mentioning that two USPCAS-E scholars, Asfandiyar Ali and Noor Ul Ain Binte Wasif Ali, have already received the USAID Youth Champions 2018 award from Paul Jones, the U.S. Ambassador to Pakistan.



MoU with PCRET signed on Dec. 18

On December 18, 2018, the U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E) at UET Peshawar signed an MoU with Pakistan Council of Renewable Energy Technologies (PCRET) to further strengthen its mission of producing materials, devices and applications in the field of renewable energy.



Minister of Education visit to UET on Dec. 18

On December 18, 2018, the Minister of Education Khyber Pakhtunkhwa Mr. Zia Ullah Khan Bangash visited the Center for Energy at UET Peshawar. He toured the facilities and was particularly impressed with the state-of-the-art research labs at the center.





Career fair brings opportunities to students

UET PESHAWAR CAREER FAIR ATTRACTS HUNDREDS OF GRADUATES

On April 10, 2019, the U.S.-Pakistan Center for Advanced Studies in Energy at University of Engineering and Technology (UET) Peshawar organized its first Youth Employment Expo 2019 for the youth of Khyber Pakhtunkhwa (KP), focusing on engineering, information technology (IT), and business. Held in collaboration with the KP IT Board, the World Bank Group, Sustainable Energy for Pakistan (SEP), Women in Renewable Energy (WIRE), ACCA Pakistan and Khawateen Rozgar Services, the event provided local students and graduates access to many career and employment opportunities.

Over 2,000 graduates interacted with representatives from about 60 private and public sector organizations at the expo. The event also provided two parallel sessions for youth to explore market demand and the required skillsets for successful careers. One session focused on resume writing, job search and interview skills while the second facilitated interaction with human resources professionals and interviews

of potential candidates for jobs and internships.

Special Assistant to the Chief Minister KP for Science and Technology Kamran Bangash and Vice-Chancellor of UET Peshawar Dr. Iftikhar Hussain inaugurated the Youth Employment Expo 2019 and delivered motivational speeches to the audience.

A graduate shared, "This event was a great opportunity to connect with industry. I learned about the needs of current job sector, and the capacity development sessions arranged here increased the young graduates confidence in themselves."





USPCAS-E scholars visit Kohat Textile Mill

On June 18, 2019, USPCAS-E scholars from the University of Engineering and Technology Peshawar visited the Kohat Textile Mill.

These scholars are currently enrolled in the M.S. in Energy Management and Sustainability program at USPCAS-E. The visit focused on the production process of cotton and synthetic yarn as well as the power system installed at the factory that is providing 4MW electric power to the mill.

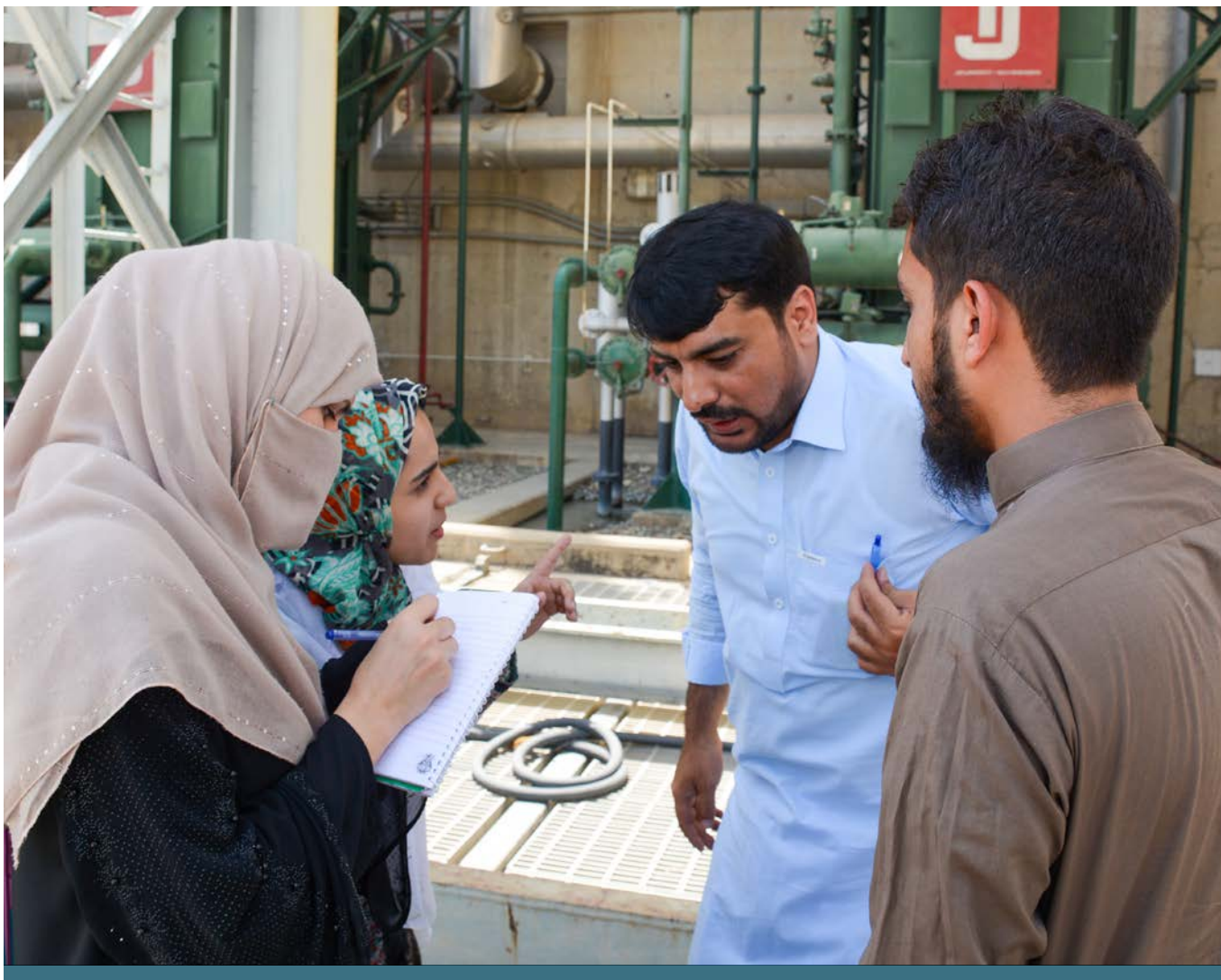
They learned how this system is providing a localized source of power for the mill, with high fuel efficiency and a reduction in the energy loss associated with long-range electricity transmission.

The scholars also discussed the possibility of deploying an environmentally friendly heat recovery system to further reduce energy consumption at the mill.

USPCAS-E scholar Syed Faisal Shah said,

“During the Q&A session with management, I learned about their corporate policy, environmental assessments and sustainable production. Some fruitful discussions were held on power factor improvement that may be helpful for minimizing their power losses and reducing inefficiencies.”

Another scholar, Danish Shahzad, notes that such industrial tours bridge the gap between theory and practice and help students learn about real industry challenges.



Industrial visit to Pakistan's Tarbela Power Plant

Initially built as a water reservoir, the Tarbela project, one of the world's largest earth-filled dam, is now producing over 4,000MW electricity for Pakistanis.

Electrical Systems Engineering master's students from USPCAS-E at UET Peshawar visited the Tarbela Power Plant on July 2, 2019, as part of the industrial visits program. The scholars learned about the construction history of the project and then visited the power station. They visited the control center and got a first-hand look at the turbine and generator functioning at different levels of the powerhouse.

"This visit helped me gain further knowledge of hydropower generation particularly in the area of transformer protection and turbine monitoring at powerhouses," shares Ms. Bushra, a second-

semester student in the master's program.

"The visit to Tarbela Power Plant was an amazing experience for me. I saw for the first time working of an autotransformer used for the transformation of voltages (either step up or step down) according to load changes in the switchyard. I also saw single windings high-power transformers of 220kv and 500kv. Most interesting for me was seeing the governors installed on generators for the activation of primary reserves," notes another student, Mr. Azmat.

USPCAS-E arranges industrial visits for scholars to discuss ideas for possible research topics, bridge the gap between theory and practice, and help them learn about real-life industry challenges.



USAID Youth Festival celebrates young Pakistanis

The United States Agency for International Development (USAID) organized a Youth Festival on October 4, 2018, providing a platform to Pakistani youth to discuss and explore topics including education, jobs, entrepreneurship, power, healthcare, peacebuilding, infrastructure, clean water, the environment and gender equality. The event celebrated the accomplishments of inspiring young Pakistanis who are actively making a difference in their communities.

Two USPCAS-E scholars — Asfandiyar Ali and Noor Ul Ain Binte Wasif Ali — received the USAID Youth Champions 2018 award from Paul Jones, the U.S. Ambassador to Pakistan.

Noor Ul Ain Binte Wasif Ali recently completed her M.S. in Energy Systems Engineering from USPCAS-E and was nominated for the presidential gold medal for her undergraduate class. She is working on the sustainability of environmental and energy systems. She has completed 20 impact assessment studies of incinerator installation projects in 17 districts of Pakistan. She recently won a student grant of 0.5 million rupees for a USPCAS-E applied research project in the field of solar thermal engineering and is working on the development of a novel water desalination unit.

Asfandiyar Ali was one of two USPCAS-E scholars to win the USAID Youth Champions 2018 award.

As a child, Asfandiyar Ali's world was changed forever by a deadly earthquake in Pakistan on October 8, 2005. He lost his friends and his school — even his home was completely destroyed.

Later, he also lost his father after a prolonged illness. After 13 years of hard work, Asfandiyar is an engineer determined to bring electricity to the villages of Muzaffarabad in Azad Jammu and Kashmir. He says that his semester at ASU as an exchange student equipped him with entrepreneurial and applied research skills

"Let passion fuel your journey through any ups and downs that come along the way," says Asfandiyar.





Engineering
Research
Center

ENGRC

551

Learn more

uspcase.asu.edu

