



FINAL REPORT

2014 – 2019

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

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



USAID
FROM THE AMERICAN PEOPLE





Muneeza Ahmad



Fortunately, I was able to secure the USAID scholarship so I could focus on my education without having to worry about money.



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.

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.”

USPCAS-E Project

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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.



Samia Subhan Qureshi



**I am the first
female engineer
of my family.**



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.”

EXECUTIVE SUMMARY

Create a compelling vision, one that takes people to a new place, and then translate that vision into a reality.

– Warren Bennis,
pioneer in the field of leadership studies

Energy is the lifeblood of modern society. Without consistent access to affordable, reliable and sustainable energy, all sectors of an economy are endangered. Pakistan is the fifth most populous country in the world; its population doubled between 1990 and 2019. Access to electricity has improved for Pakistan, but with frequent one- to two-hour outages per day, reliable power remains out of reach. Furthermore, over the past 20 years, Pakistan's energy source has shifted from mainly renewable hydro energy to diesel and fossil fuel-based energy sources. In addition, Pakistan lacks the necessary workforce of trained engineers, energy experts and policymakers to assist with future energy planning and development. These disruptions exact a high cost for businesses and severely impact the quality of life for all Pakistanis. Affordability in Pakistan is significantly affected by a high reliance on oil-based energy solutions.

The U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E), funded by USAID, is a project that was conceived to deliver practical energy solutions and establish energy-focused graduate degrees to address Pakistan's energy crisis.

The project sought to harness the strengths of existing universities and partner with a U.S. university to create two new energy centers offering graduate degree programs in energy and a culture of applied research. The overarching goal for the five-year (2014-2019) project was to develop immediately available bandwidth in people, including leadership and a trained workforce; power; and solutions, especially in the area of renewable energy.

In 2014, USAID funded the USPCAS-E program at Arizona State University (ASU), a partnership between ASU and two leading Pakistani universities: the National University of Sciences and Technology (NUST) and the University of Engineering and Technology (UET) Peshawar, along with U.S.-based partner Oregon State University (OSU).

The vision: develop groundbreaking energy research and energy solution hubs in Pakistan. This program was made possible by an \$18 million grant to ASU, a \$15 million grant to UET Peshawar and a \$15 million grant to NUST as part of a larger USAID investment to support Pakistan's economic development by strengthening universities.

Through this partnership, ASU is leveraging its expertise in higher education, university design, applied research and energy to help Pakistan release its enormous potential for economic growth through its universities. Partnering with USAID, ASU coordinated subject matter experts and applied cutting-edge knowledge on the front line of research and innovation. USPCAS-E focused on applied research relevant to Pakistan's energy needs, helped to produce skilled graduates in the field of energy; and served as a bridge between the government, industry and academia.

ASU was excited to collaborate with USAID and these two universities to open up new educational opportunities and address the critical need for a sustainable energy supply in Pakistan. With technical guidance from ASU, and under the umbrella of the Higher Education Commission (HEC) of Pakistan, the centers at NUST and UET Peshawar are poised to become Pakistan's premier sustainable energy think tanks that will harness practical solutions for Pakistan's current and future energy needs.

PROJECT IMPACT

The impact of the USPCAS-E project can be summed up in three broad areas: infrastructure, workforce development, and sustainable structures and finances. The infrastructure is both physical and intellectual. The new facilities provide the space and place for research, learning and knowledge-generation to occur — but without the corresponding intellectual infrastructure, they are just office space. Preparing a workforce by producing skilled graduates working for a renewable energy future has wide-ranging impacts that ripple across individual lives, families, communities and the country as a whole. Central to this is the creation of a culture of research. Curiosity and scientific rigor systemically and consistently applied set the stage for boundless growth and innovation. And finally, all good ideas need a plan to sustain them both in terms of enthusiasm and finances. Sustainability was built on relationships with stakeholders; connection to the broader energy landscape; and contributions to the marketplace in the form of services, key trainings and continuous education.

PROJECT IMPACT

Infrastructure

- Physical: Two new state-of-the-art buildings
- Intellectual: Faculty, researchers and graduates

Workforce development: faculty and graduates

- New degrees and curriculum
- Applied research
- Exchange programs with hands-on training at ASU

Sustainability

- Foster a culture of research and entrepreneurship
- Industry interaction and fundraising
- Technology Centers, short courses and testing services

PROJECT ACCOMPLISHMENTS

In five years, the U.S.-Pakistan Centers for Advanced Studies in Energy have:

- Enrolled more than 1,000 master's and Ph.D. students in energy graduate programs.
- Created 13 modern degree programs and 151 industry-relevant courses.
- Developed governance structures that facilitate an ongoing dialogue about energy education and research needs in Pakistan. Ten stakeholder and Think Tank meetings engaged nearly 500 representatives from Pakistan's energy sector, including academia, government, NGOs and industry.
- Offered in-country training on a wide variety of technical topics. More than 30 hands-on workshops and seminars related to various energy sectors were offered.
- Created 16 state-of-the-art labs and two libraries.
- Hosted 217 students and faculty for a semester-long exchange experience at ASU and OSU in the U.S., where scholars were embedded in a sophisticated research university using the latest equipment, techniques and protocols in energy policy, photovoltaic reliability, power systems, energy materials, fuel cells and batteries and thermal energy.
- Graduated more than 375 students from the centers at NUST and UET Peshawar with advanced degrees in energy — with many more students in the pipeline.
- Secured 121 internships for USPCAS-E students.
- Hired 45 new faculty members.
- Recruited and supported women and disadvantaged students in energy engineering programs.
- Raised more than \$2 million from public and private entities.
- Developed the framework and extensive training for Technology Centers at each center; these centers will offer critical testing services and training opportunities in photovoltaics.

The work of the centers also created some intangible but equally important outcomes.

- Exchange scholars consistently highlighted the value of the exchange experience, often calling it transformational.
- Many individuals breached the entrenched silos of academia, industry and government by offering research-based and also practical, actionable solutions to pressing needs.
- The research culture has been strengthened through many applied and joint research projects and the successful interactions with industry, government agencies and international colleagues.
- Faculty and staff have been exposed to leadership training, fundraising and proposal-writing skills that can be transformative as the centers become self-supporting.

There are many people who helped to make this project a success: leaders at USAID, HEC, NUST, UET Peshawar, ASU and OSU; faculty, staff and students from NUST and UET; faculty, staff and students at ASU and OSU; leaders and collaborators from governmental entities, private industry, non-profits, and non-governmental agencies; and, of course, the project teams. Stakeholders were generous with their time and insights to guide our efforts, and the USPCAS-E students inspired us with their stories, their perseverance, and their commitment to finding energy solutions for Pakistan. We thank every person who worked to make the centers a success.

Warren Bennis said, "Success in management requires learning as fast as the world is changing." The same could be said for energy. The Centers for Advanced Studies in Energy at NUST and UET Peshawar have created incredible new infrastructure, programming and capacity for learning. The next step is maintaining this momentum to keep up with a future that is always in motion.



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 Masters & Ph.D. **DEGREE PROGRAMS**

375+ **GRADUATES**

More than 500 projected by the end of the 2019 academic year

1000+ enrolled to date **M.S./PH.D. STUDENTS**



150+ **NEW COURSES** offered

36 **APPLIED RESEARCH PROJECTS**

12 **JOINT RESEARCH PROJECTS** with U.S. & Pakistani researchers

14 **TECHNICAL WORKSHOPS** with visiting experts

9 **VIRTUAL SEMINARS**

217 **EXCHANGE VISITORS**



Female: **25%**

555 **SCHOLARSHIPS** awarded



Semester-long research experience



Cultural and academic excursions



Entrepreneurial training



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**



Sara Sultan



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



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."

SECTION

1

ACTIVITIES AND ACCOMPLISHMENTS

The U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E) project was launched in 2014 as a five-year project to foster innovative solutions to Pakistan's energy challenges through governance, leadership development, collaborative and applied research, advancements in curriculum and technology, exchange programs, technical training, policy development, and advocacy.

Pakistan's economic growth and security require stable and sustainable energy systems that can reliably support businesses and communities nationwide. USPCAS-E taps into the potential of higher education to develop real-world solutions. Energy experts from ASU and OSU partnered with faculty members from the National University of Sciences and Technology (NUST) and University of Engineering and Technology Peshawar (UET Peshawar) to form transdisciplinary and cross-cultural research teams to share knowledge, research and the latest industry developments.

Through technical assistance provided by ASU and under the umbrella of the Higher Education Commission (HEC) of Pakistan, the centers at NUST and UET Peshawar are expected to become Pakistan's premier energy think tanks generating cost-effective and sustainable solutions to meet Pakistan's energy challenges. Sound governance, applied

research, a modernized curriculum and the application of the latest teaching strategies and methods were employed to produce skilled graduates and increase the energy knowledge base in Pakistan. The project was also committed to supporting the success of both Pakistani women and disadvantaged youth in the engineering profession.

NUST and UET Peshawar are now poised to respond to changing public and private sector needs with top facilities, applied research, teaching, skilled graduates and capable leaders in the energy sector.

THE EFFORTS OF THE USPCAS-E PROJECT FOCUSED ON FIVE COMPONENT AREAS:

1. Governance
2. Curriculum
3. Research
4. Exchange
5. Sustainability

Activities in all five areas were designed to increase indigenous leadership, technical ability, innovative solutions via applied research, and financial sustainability.

3 RESEARCH

- Applied research projects
- Joint Research projects with ASU
- Industry Projects
- Internships

2 CURRICULUM

- Electric, Renewables Thermal, Policy, Hydro
- 9 MS, 5 PhD degrees
- 140+ courses
- 800+ MS/PhD students

1 GOVERNANCE

- National Council
- Research and Curriculum Committees
- Think Tank
- Stakeholders



CORE AREAS OF FOCUS AND EFFORT

4 EXCHANGE PROGRAMS

- Power, grid, solar, materials, thermal, battery, policy
- ASU & OSU Labs
- +200 Exchange Scholars
- Female students ≥ 30%

5 FINANCIAL SUSTAINABILITY

- Technology Center
- Short Courses
- Voc Tech Centers
- Industry

PROJECT GOALS

- Student and faculty exchange programs between U.S. and Pakistani universities to support the academic and research advancement of Pakistani students and faculty by providing an opportunity to conduct cutting-edge energy research in state-of-the-art labs at ASU and OSU
- Modernized curricula and teaching methods and relevant advanced degree programs covering power systems, electric grid and distribution systems, thermal energy, renewable energy, solar energy, biomass and energy policy
- New channels to facilitate local and international networking in the energy sector for promoting academia-private sector collaboration and finding solutions for Pakistan's energy challenges
- Greater access to energy-related professions for women and economically disadvantaged students through inclusion and scholarships
- Strengthened university capability to deliver quality applied research in energy
- Regular policy dialogues with Pakistan's public and private energy stakeholders promoted through the establishment of a think tank on energy at both NUST and UET Peshawar

KEY ACCOMPLISHMENTS

- Two new buildings at NUST and UET Peshawar providing 114,000 square feet of research and classroom space
- Sixteen state-of-the-art labs and two libraries (NUST: 10 labs, 1 library; UET Peshawar: 6 labs, 3 sub labs, 1 library)
- Supported 36 applied and 12 joint (U.S.-Pakistan) research projects to address pressing energy problems in Pakistan (NUST: 14 applied research, 6 joint research projects, 17 student research projects; UET Peshawar: 22 applied research projects, 6 joint research projects)
- Developed 13 new degree programs and 151 graduate-level courses in cutting-edge energy fields (NUST: 6 new degree programs plus an Energy Policy Program approved by NUST [HEC approval awaited with an expected launch date of fall 2020], 51 new courses and 20 existing courses revised; UET Peshawar: 7 degree programs, 80 new courses)
- More than 1,000 students have enrolled in energy-related graduate degree programs (NUST: 636 students enrolled, 17.8% female; UET Peshawar: 462 students, 11% female)
- More than 200 students and faculty from NUST and UET Peshawar completed an exchange program in the United States (NUST: 109 exchange students and faculty, 27.5% female; UET Peshawar: 99 students and 9 faculty, 21.5% female)
- 555 scholarships were awarded (NUST: 305 awarded, 19% female; UET Peshawar: 250 awarded, 13% female)
- Raised \$2.2 million through public-private partnerships (NUST: raised \$1.16 million; UET Peshawar raised \$1.06 million)
- Nearly 500 attendees from government and private sector engaged at six stakeholder meetings
- 121 internships secured for students (NUST: internships for 71 students including 18% female students; UET Peshawar: internships for 50 students including 6% female students)
- 14 technical workshops, nine virtual seminars, and 3 trainings conducted for students and faculty
- 377 graduates to date (NUST: 243; UET Peshawar: 134); more than 500 projected by the end of the 2019 academic year



1 GOVERNANCE

USPCAS-E worked to facilitate industry and stakeholder engagement by focusing on the collaboration needed to develop world-class centers of energy engineering that will serve as go-to think tanks for Pakistan. Informed by private and public sector stakeholders, these centers were designed to provide technical and policy expertise to power the future.

USPCAS-E worked in partnership with Pakistan's Higher Education Commission (HEC) to build a governance framework for the centers. HEC provided oversight for the steering committee, approval of degree programs and guidelines for scholarships.

Governance objectives	
1.1	Assist in the establishment of a National CAS Advisory Committee
1.2	Assist in the establishment of Steering Committees at UET Peshawar and NUST
1.3	Assist in the establishment of the Committee on Research Policy (CRP) at UET Peshawar and NUST
1.4	Support establishment of Project Management Units (PMU)
1.5	Advise on responses to self-assessment of needs and institutional capacity at centers
1.6	Organize workshops, conferences and short-term consultancies to support the development of strategic and implementation plans for NUST and UET Peshawar
1.7	Provide training and assistance to promote efficiency, client responsiveness, cost-effectiveness, transparency and sustainability (including grants) in center operations

Establishment of USPCAS-E at NUST: At the inception of the project, the Center for Energy Systems (CES) existed at NUST. Established in 2012, it had one program, Energy Systems Engineering. This basic structure served as the foundation for creating the U.S.-Pakistan Center for Advanced Studies in Engineering. From modest beginnings, this presence has grown to include a 60,000 square-foot modern research building with 10 state-of-the-art laboratories and a vibrant student body. More than 600 students enrolled at the center in three programs: Energy Systems Engineering

(ESE), Thermal Energy Engineering (TEE) and Electrical Engineering (Power) (EEP). The center has established itself as a well-regarded institution for energy studies.

ASU was engaged by USAID to provide technical support to NUST in the implementation of the project. ASU fulfilled its commitments as outlined in the Cooperative Agreement with USAID, and its role was critical in the successful establishment of USPCAS-E at NUST. ASU provided extensive support to NUST in governance, curriculum development, applied research, exchange and sustainability.

With strong leadership at the center, all USPCAS-E project objectives were successfully achieved. When the NUST component of the project closed on Sept. 4, 2019, the center was fully integrated with the NUST system — a seamless transition. After the project management unit (PMU) closed, the center continues to function without any issues.

USPCAS-E AT UET PESHAWAR

The overall goal of the center at UET Peshawar was to substantially improve the capacity of University of Engineering and Technology (UET) Peshawar to find innovative solutions to some of Pakistan's greatest development challenges in the energy sector through applied research, graduates who are better prepared to meet the needs of industry, government and their communities, and leadership in policy dialogue. Key objectives of the center included:

- Increase access for talented, economically and culturally disadvantaged students, as defined by the Government of Pakistan, in the discipline of energy
- Establish governance structures for sustainability
- Improve relevance and quality of curricula, strengthen the use of effective teaching methods, and upgrade graduate and post-graduate programs
- Apply relevant research to meet client (industry, civil society, government) needs

Since 2015, ASU worked with the vice chancellor and the dean at UET Peshawar to develop center governance and assist with the day-to-day operations of the center. This included the hiring of new faculty, research associates and lab engineers. ASU facilitated capacity-building exercises for staff, securing USAID approvals for staff, assisting in the completion of annual performance evaluations, and revising and clarifying job roles and responsibilities. ASU also assisted UET Peshawar in revising the human resources manual and finance manuals, as well as the sustainability plan, faculty hiring plan, laboratory and library functionalization plans.

ASU provided extensive support to UET Peshawar in governance, curriculum development, applied research, exchange and sustainability. ASU, together with UET Peshawar management, held meetings with senior officials of the Khyber Pakhtunkhwa government to ensure the commitment of funding in the provincial budget and provide support for the sustainability of the center.

ENSURING THAT COMMITTEES ARE FUNCTIONING AND SUSTAINABLE

▼ Forums at NUST and UET Peshawar

	Forum	Chair
1	National Advisory Committee	Chairman, HEC
2	Steering Committee	Rector NUST/ Vice-Chancellor UET
3	Committee on Research Policy	Pro Rector, NUST/ Vice-Chancellor UET
4	Project Review Committee	Pro Rector, NUST/ Dean, UET
5	Research Evaluation Committee	Pro Rector, NUST/ Dean, UET
6	Exchange Selection Committee	Pro Rector, NUST/ Dean, UET

ASU provided technical insights, advice and recommendations to the National Advisory Committee, the Steering Committee and the Committee on Research Policy (CRP) on matters pertaining to governance, research, curriculum and sustainability. ASU worked with partners to structure a realistic and achievable plan of action to institutionalize the centers within their universities and supported the creation of energy think tanks for the centers. ASU actively contributed to four meetings of the National CAS Advisory Committee and developed joint presentations with NUST and UET Peshawar for the meetings.

In addition to reviewing the terms of reference (ToR) for the steering committees and providing feedback, ASU participated in all steering committee meetings at NUST and UET Peshawar and followed up on action items from these meetings.

ASU technical advisors participated in all CRP committee meetings at NUST and UET Peshawar, reviewed projects and other documents to be presented in the meetings, and followed up with NUST and UET Peshawar on action items. ASU also ensured that all local applied research projects (LARPs) and joint applied research projects (JRPCs) were selected based upon their relevance to the national energy needs.

Governance forums (Steering Committee, Committee on Research Policy): ASU actively participated in the establishment of governance forums at NUST and UET Peshawar. The support included the review and finalization of the terms of reference, participation in committee meetings as a member and contributing to the decision-making process. At NUST, the forums met regularly, which resulted in a continuous review of progress and strategic direction, as well as timely decision making. Prompt course corrections enabled NUST to meet the work plan objectives.

National Advisory Committee: With USAID's support, the Higher Education Commission established the National Advisory Committee. It is the highest decision-making forum and exists to provide strategic guidance to the three Centers for Advanced Studies. The committee was chaired by the chairman of HEC and included members from all Centers for Advanced Studies, including Food Security, Water and Energy. Membership included the Pakistani partner universities: University of Agriculture Faisalabad, Mehran University of Engineering and Technology, National University of Sciences and Technology and University of Engineering and Technology Peshawar; and U.S. partner universities: University of California Davis, University of Utah and Arizona State University. This committee held four meetings during the project to review progress, discuss yearly work plans and provide strategic direction to all centers.

IMPACT

Strong forums resulted in effective decision making, which was the key to the successful implementation of the project.

Project Management Units (PMU): ASU actively engaged with NUST and UET with establishing their respective Project Management Units (PMU). ASU provided input in the finalization of the terms of reference, selection of members and later participated in the meetings. ASU faculty and staff participated in the meetings both in-person and via Skype and provided management and technical inputs, despite the 12-hour time difference.

ASU's Deputy Director for UET Peshawar served as interim co-director for USPCAS-E at UET Peshawar during FY2017. He coordinated the hiring of key PMU staff, developed and revised operational manuals, provided oversight for the move to the new building and the installation of lab equipment, awarded local applied research projects, developed linkages with government and private sector partners, and provided overall management for the center for six months while UET hired a director.

PMU Review: ASU initiated a mid-term review of the PMU for effective project implementation. Terms of reference for the mid-term performance (institutional) review of the PMU were developed in consultation with NUST, UET Peshawar and USAID, and ASU provided support to NUST and UET Peshawar in the mid-term review. ASU reviewed the mid-term review report and provided feedback to NUST and UET Peshawar. The review helped in further strengthening the PMUs, making them better equipped to meet the project objectives and address challenges faced in the implementation.

IMPACT

Strong functioning PMUs resulted in the effective programmatic and operational implementation of the project.

FACILITATING SELF-ASSESSMENT

ASU developed a self-assessment tool for NUST and UET Peshawar at their request. The development of this self-assessment tool is beyond the scope of the Cooperative Agreement but was deemed critical to promoting the long-term sustainability of the centers. Self-assessment activities included a review of the Energy Systems Engineering program at NUST, the entire USPCAS-E program at UET Peshawar, and specifically, the Renewable Energy program, which included input from a panel of ASU experts.

Four-Way Memorandum of Understanding (MoU):

The USPCAS-E project was implemented under three cooperative agreements: NUST-USAID, UET-USAID, and ASU-USAID. Although the three cooperative agreements did refer to the other project partners, cooperation was not binding. This left significant gaps in how the three institutions would work together for the implementation of the project, including roles and responsibilities. Despite being a major stakeholder in the project, no role was specified for the Higher Education Commission (HEC) in the Cooperative Agreements. However, the Cooperative Agreements did reference a memorandum of understanding among the four institutions. ASU realized the need to codify this with HEC, ASU, NUST and UET Peshawar very early on and prepared a draft for the consideration of all partners. As per this MoU, the three universities (ASU, NUST and UET Peshawar), along with HEC, explicitly stated the intention to work together to support the development and activities of the respective Centers for Advanced Studies in Energy as a

collective resource for the Government of Pakistan as they address the future energy needs and priorities of Pakistan. After ongoing efforts by ASU, the document was signed by HEC, NUST, UET Peshawar and ASU on Nov. 7, 2017.

The document defined the roles and responsibilities of each partner to achieve the project objectives. The document also served as the primary document for conflict resolution, if needed. Despite administrative and geographical constraints, the MoU provided the framework for all partners to work together toward a common goal.

IMPACT

Despite three separate cooperative agreements that lacked an explicit commitment to collaborate, the partners worked together and successfully achieved their agreed-upon targets.

Strategic Planning: Strategic planning is a core skill that must be developed in all organizations. ASU provided regular strategic planning guidance and also organized a one-day session on strategic planning for senior management and faculty to assist the centers in the drafting of strategic plans, a key requirement of their Cooperative Agreements. ASU reviewed the strategic plans and provided extensive feedback to both NUST and UET Peshawar. Later this initial plan was replaced by a new version, and ASU again reviewed the plan and provided extensive feedback, which helped the centers in finalizing the plan.

Leadership Training: ASU organized a training on modern leadership principles for USPCAS-E faculty and staff. The training, Leadership in Higher Education: Academic Strategic Planning and Execution, was conducted by ASU Professor Dan Shunk, an industry expert with over 40 years of experience in organizational leadership. The training established a baseline for sustainable ventures and provided insights on creating successful startup ventures as well as a roadmap for financial sustainability after the funded project ended.

IMPACT

Making the successful transition from a funded project to an independent functional center was one of the stated outcomes of the leadership training. However, the real impact will become visible at least one year after the closure of the project.

Other Trainings: ASU also conducted other trainings which directly or indirectly resulted in better governance at the center. ASU provided a training on gender equity, Awareness and Strategy Building for Gender Equity in Engineering. The training was conducted by ASU Associate Professor Chad Haines and attended by USPCAS-E faculty and leadership

along with other project stakeholders. Gender awareness and integration are structural weaknesses in Pakistani institutions and the root cause of some governance challenges. The training increased awareness and ultimately helped the centers take action on gender integration, starting with the drafting of a Gender Integration Plan. The gender ratio in enrollment and exchange improved, which resulted in better gender integration in the governance of the center.

Click to see the **Annex** for a complete list of **trainings and workshops**

Partner Liaison: ASU maintained close communication with the partners to ensure high quality and timely support. ASU adopted various engagement methods such as regular in-person meetings, bi-monthly Skype calls, quarterly visits of ASU's senior project management to Pakistan for project-related activities; faculty visits to conduct workshops and seminars and to meet with research collaborators; bi-annual virtual seminars; and visits of NUST and UET Peshawar management and faculty to ASU and OSU. ASU's multi-pronged approach enabled the partners to achieve their objectives and establish full-fledged energy research centers.

Conference Support: ASU supported the partners in hosting the following conferences:

- A joint international conference hosted by UET Peshawar and NUST.
- An international conference hosted by UET Peshawar.
- Four national conferences hosted by UET Peshawar.
- A national conference hosted by NUST.

FOSTERING PARTNERSHIPS AND ENSURING SUSTAINABILITY

Stakeholder engagement was seen as critical to the success and sustainability of the Centers for Advanced Studies in Energy. The centers are developing a critical mass of expertise, creating an educated workforce through the preparation of graduate students, developing technical and policy solutions, and providing technical bandwidth to public and private energy organizations in Pakistan. To promote modernization and relevance of the curriculum, strengthen policy decisions and drive innovation, USPCAS-E engaged with a wide range of energy sector stakeholders in Pakistan via one-on-one meetings and stakeholder forums. There were many ways that energy sector stakeholders could engage with USPCAS-E throughout the project, from sponsorship of research projects to working with faculty, to hiring interns and graduates.

Ongoing engagement with stakeholders through one-on-one meetings and industry visits affirmed that the centers were developing relevant curricula and research agendas responsive to both public and private sector needs for the long term.

The stakeholder meetings provided an opportunity for stakeholders to learn more about each of the USPCAS-E program components: curriculum, research, exchange, governance and sustainability. The meetings provided the latest information on degree programs and research projects and a forum for input and feedback. The capacity-building aspects of USPCAS-E are critical to future success and sustainability. Stakeholders had the opportunity to provide input to ensure that real-world challenges in the field informed the student experience in the classroom and lab.

GOVERNANCE ACCOMPLISHMENTS

✓ **Governance framework established** and **committees formed** and functioning

✓ **Staff hired**; vacancies covered as needed

✓ **Manuals developed** and **approved**

✓ **Facilitated PMU** organization and review

✓ High-quality and timely **support provided** to partners

✓ Regular **stakeholder engagement**

✓ Leadership **training provided**

2 CURRICULUM

USPCAS-E sought to create a modern, relevant curriculum by developing new courses and degree programs that translate work in the classroom and lab into the public and private sectors in a pragmatic and applied manner with a focus on immediate real-world applications.

The centers developed new energy curricula in power systems, electric grid and distribution systems, thermal, renewable energy (including solar and biomass), energy policy and related areas to be responsive to Pakistan's needs. Faculty focused on experiential learning, internships and student participation in multidisciplinary research to develop broadly applicable, transferable skills.

Curriculum objectives	
2.1	Support in creating Curriculum Development Working Group (CDWG) and sub-committees as appropriate, with committees including stakeholder representation
2.2	Assist in the launching of existing university curriculum committees as needed to improve the variety and quality of coursework (including across sectors) offered by NUST and UET Peshawar
2.3	In collaboration with the other CAS universities, HEC, and public and private sector stakeholders, develop graduate and postgraduate training policies and plans to support CAS provision of advanced research and experiential learning opportunities linked to qualitative improvements in teaching, curriculum and research

Program Development: ASU's support to NUST and UET Peshawar helped them to not only meet but to exceed Cooperative Agreement targets. ASU assisted in the drafting of the program working papers for TEE, EEP and EPM. The late Professor George Karady (ASU) co-authored the working paper for EEP and Professor Clark Miller (ASU) co-authored the paper for EPM. The relevant ASU and OSU faculty reviewed all working papers. Later, ASU faculty and staff also participated in various university forums for the review and approval of the curriculum. If in-person participation was not possible, ASU faculty participated via Skype.

ASU faculty's support was instrumental in the preparation of energy engineering curricula that met international best practices, making the programs comparable to any reputable energy school or center in the world. This would not have been possible without the commitment and the high academic standards of ASU faculty and leadership. The curricula of several leading universities were reviewed, and comparative statements prepared to ensure the best material was selected for the curricula, resulting in similarly high academic standards.

Curriculum Development: ASU supported NUST in the selection and development of five new programs at NUST in line with the best international practices. As mentioned earlier, the Center for Energy Systems existed at NUST before the start of the project. At that time, only one program, Energy Systems Engineering, was being offered. As per the Cooperative Agreement, NUST's goal was to provide three new programs and 20 new courses. However, NUST exceeded its target and developed and offered five new programs: Ph.D. in Energy Systems Engineering, master's and Ph.D. in Thermal Energy Engineering, and master's and Ph.D. in Electrical Engineering (Power). A new program on Energy Policy and Management (EPM) has also been developed and approved by NUST forums but is pending approval from HEC. EPM is scheduled to be launched in fall 2020. Similarly, UET Peshawar was provided technical support by ASU in the identification and development of four master's and two Ph.D. programs, including Renewable Energy Engineering (REE), Thermal Systems Engineering (TSE), Electrical Energy System Engineering (EESE), and Energy Management and Sustainability (EMS). Hydropower Engineering is scheduled to be launched in fall 2020.

ASU proactively involved stakeholders in the development and later review of the curriculum. Relevant industry and government stakeholders were invited for curriculum committee meetings for their input and comments. In addition, a discussion on curriculum development and review was an important agenda item at every stakeholder meeting during the USPCAS-E project. The feedback received from stakeholders was debated and incorporated in the relevant stream or course and submitted to the appropriate forum for approval. The feedback from stakeholders was not limited to the forums. Relevant stakeholders were regularly contacted by NUST and ASU and were always willing to help whenever approached for input.

The entire purpose of involving stakeholders was to ensure that the curriculum reflects international standards and is relevant to the needs of Pakistan's energy sector.

ASU supported USPCAS-E UET Peshawar in the finalization of the master's in Hydropower Engineering. ASU led the curriculum development effort and engaged relevant stakeholders. ASU developed the complete curriculum in consultation with USPCAS-E and the UET Peshawar's Civil Engineering Department. The ASU team supported UET Peshawar in securing the approval of the master's Hydropower Engineering curriculum from the Board of Studies and Academic Research (BOSAR) of UET Peshawar.

IMPACT

ASU also assisted UET Peshawar in the development of a master's in Energy Storage and Conversion (MESCC) graduate program. This program later became the Master of Renewable Energy Engineering program.

▼ Energy Programs at NUST

Stream	Programs	Status	
1	Energy Systems Engineering	MS, Ph.D.	Active
2	Thermal Energy Engineering	MS, Ph.D.	Active
3	Electrical Engineering (Power)	MS, Ph.D.	Active
4	Energy Policy and Management	MS	Will be offered beginning fall 2020

▼ Energy Programs at UET Peshawar

Stream	Programs	Status	
1	Electrical Energy Systems Engineering	MS, Ph.D.	Active
2	Renewable Energy Engineering	MS, Ph.D.	Active
3	Thermal Systems Engineering	MS	Active
4	Energy Management and Sustainability	MS	Active
5	Hydropower Engineering	MS	Will be offered beginning fall 2020

Course Development: ASU assisted its partner universities in the development of 151 new courses plus revisions to 20 existing courses at NUST. Different methodologies were adopted for the development of new courses. Some courses were developed exclusively by ASU faculty and staff and shared with Pakistani faculty. In some cases, the courses were developed jointly by ASU and local faculty. Other courses were developed by local faculty and later reviewed by ASU faculty and then finalized. The existing courses were reviewed by relevant ASU faculty and detailed input provided for incorporation by NUST and UET Peshawar for finalization.

Click to see the **Annexes** for lists of **new courses developed at NUST and UET Peshawar**

Curriculum Review: Because curriculum development is a dynamic process requiring regular review and updates, ASU continued to provide curriculum-related support throughout the project. ASU conducted two comprehensive curriculum reviews for all programs in 2016-17 and 2018-19. The review examined course content, its suitability in light of national needs, alignment with international best practices, and all textbooks and reference material. All reviews were conducted by relevant ASU and OSU faculty. Skype calls were also held to discuss and finalize reviews.

ASU faculty and staff also participated in the related forums, including the University Curriculum Review Committee meetings, to support the center faculty in approval of the recommended amendments. The reviews helped the partners to further improve the curriculum and ensure that it reflected the latest developments in the respective fields.

IMPACT

The centers have established themselves as credible institutions for energy education with student enrollment three years in a row. Enrollment continued to rise in fall 2019 despite the absence of scholarships and exchange opportunities.

Research Laboratories: Core to the success of center efforts was the development of top-notch facilities to support scientific inquiry and research. USPCAS-E reviewed the proposed equipment for NUST and UET Peshawar's energy labs and provided feedback in an ongoing manner based on the best-in-class equipment standards followed by other universities. USPCAS-E also reviewed and endorsed books, journals and related materials procured by the centers for their respective libraries.

Sixteen state-of-the-art research laboratories were established to support curriculum and teaching at NUST and UET Peshawar.

▼ Laboratories at NUST

1	Energy Storage and Conservation
2	Fossil Fuels Research
3	Thermal Energy Research
4	Biofuel Research
5	Advanced Energy Materials and Systems
6	Solar Energy Research
7	Smart Grids and Electrical Power Systems
8	High-Performance Modeling/Simulation
9	IT
10	Machine Workshop

▼ Laboratories at UET Peshawar

1	Renewable Energy
1.1	Material Synthesis
1.2	Materials Characterization
1.3	Solar Photovoltaic (PV) Efficiency
2	Microscopy
3	Electric Power
4	Workshop Facility

5	Simulation and IT
6	Thermal Systems

The labs were purposefully selected by ASU, NUST and UET Peshawar faculty to support the curriculum. ASU provided continuous support to the partners in the equipment selection and, at times, in the procurement from a U.S. manufacturer. Students and faculty who visited the U.S. on exchange programs were also provided training on some of the same equipment at ASU and OSU.

ASU assisted NUST in the conceptualization and development of a High Voltage Lab, and supported UET Peshawar in finalizing the Simulation and Modeling Lab for Thermal Power Plants. Assistance included identification and review of equipment and recommending high-voltage testing equipment manufacturers in the U.S. These labs will be established after project completion with the partners' own funds.

IMPACT

Cutting-edge, purpose driven research, and state-of-the-art curriculum and labs attract top students and faculty to the centers.

PEDAGOGICAL TRAINING: PROMOTING EXPERIENTIAL LEARNING AT THE CENTERS

How do you transform the classroom experience and make the learning process engaging, meaningful and relevant? As part of its efforts, USPCAS-E worked with faculty and staff to transform the energy curriculum at its partner universities in Pakistan. ASU supported both partners in adopting the latest pedagogical practices to improve course delivery and enhance the learning experience. The six-month effort included classroom observations, a three-day pedagogy training, online modules and virtual Zoom sessions (online video conferencing) focusing on the scholarship of teaching and learning. Faculty received actionable feedback to ensure that classroom instruction was 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 Shoab and Kaleem Ullah.

IMPACT

The pedagogy training was held in fiscal year 2019. Therefore, the results will not be immediately apparent. However, participating faculty reported changes to their approaches for teaching and learning. Better delivery of the curriculum will result in improved performance and overall satisfaction of students. Improvement in the student experience will enable the centers to attract more and higher-quality students, ultimately resulting in improved research output.

Online Program: NUST and UET Peshawar are continuously pushing toward their vision to achieve the highest level of engineering excellence and contribute to the socio-economic development of society through the knowledge and expertise of their graduates. Partner universities encouraged both men and women from all walks of life to find solutions to the energy challenges of Pakistan.

Due to limited financial resources, many students don't seek graduate education because they cannot afford lodging, food and the high tuition fees common in Pakistan's cities. Furthermore, many graduates are engaged in jobs at remote locations and cannot afford to travel for continuing education. Online education can bridge this gap, making graduate-level education accessible to all. Online course delivery systems not only provide professionals the opportunity to continue learning from remote locations, but they also offer access to the best faculty, state-of-the-art modeling resources, and a world-class digital library to enhance technical skills and knowledge.

USPCAS-E partners expressed interest in initiating an online education program and asked for ASU's guidance in creating these programs. In 2016, ASU compiled a document providing detailed information on its online education program, EdPlus. ASU's online program is one of the largest and most successful in the United States. During their visits to ASU, the top leadership of the partner universities received a detailed briefing on the program.

ASU assisted the center staff in getting up to speed in online course delivery for graduate courses by:

1. Identifying the appropriate learning management system (LMS) to deliver courses
2. Identifying IT requirements for the LMS
3. Identifying best practices for online course delivery at the faculty level

In June 2019, ASU organized a training program in online course delivery for faculty and staff. Dr. Hassan Tahir (faculty) and Mr. Muhammad Siddique (IT specialist) from NUST and Mr. Mansoor Yousaf (IT manager), Dr. Nasrum Minallah (Chairman Computer systems department) and Mr. Ammad Ahmad (IT Support) from UET Peshawar completed extensive training from ASU.

NUST has procured the necessary equipment and is expected to launch the program on a limited scale in 2020. UET Peshawar has 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. The system offers:

1. Interactive touch LED screen with advanced features
2. Wireless pocket microphone for presenter recording
3. Motion tracking video camera for presenter video capture
4. Media station to start and stop recordings

IMPACT

Since the support for online programs was provided at the end of the final year of the funded project, the full impact will not be realized until a few years after the program has been launched, however, NUST and UET Peshawar are well-positioned to become leaders in online program delivery, especially in energy.

CURRICULUM ACCOMPLISHMENTS

✓ **13** new degree programs developed

✓ **16** state-of-the-art labs and two libraries established

✓ **Specialized trainings:**

- Pedagogy training
- Online program development training

✓ **151** new courses

✓ **Two rounds of curriculum reviews completed**

3 RESEARCH

The centers concentrated on applied energy research directly related to energy challenges that affect the country's citizens and impede economic growth. These efforts included pairing Pakistani faculty with U.S.-based counterparts.

Research findings produced by USPCAS-E on the residential, business and energy sectors focused on providing a greater understanding of the ongoing and future energy challenges in Pakistan. The goal of the research component was to nurture and promote the culture of applied research at the newly created centers. The centers were tasked with finding practical solutions for Pakistan. Applied and joint research projects focused on finding indigenous solutions to increase access to reliable and renewable energy.

ASU supported NUST and UET Peshawar in fostering a culture of research that included the adoption of modern research methodologies and techniques, and promoting research ethics, while also recognizing the current pressing needs in communities across the county.

Applied research grants built the grant-making capacity and capabilities of center faculty while creating an ideal hands-on learning environment for graduate students. The overarching goal was to develop new energy systems, tools, policies and models to improve the generation, distribution and access of energy in Pakistan.

Research objectives

3.1	Support in conducting stakeholder meetings to set an applied research agenda
3.2	Supplement the materials available to purchase additional equipment needed for laboratory, research and library equipment and materials and assist center partners to develop plans for laboratory and library improvements
3.3	Convene policy dialogues among key stakeholders
3.4	Conduct applied research in collaboration with center partners

STAKEHOLDER ENGAGEMENT

Many projects have a well-defined beginning and end. But if the end is just the beginning? The USPCAS-E project worked to ensure that the end of the USAID-supported project would mark the beginning of a sea change: a broad transformation of energy engineering research and education in Pakistan.

To engage and inform its stakeholders, USPCAS-E hosted regular meetings and Think Tank dialogues to share project updates and outcomes, and to invite input and feedback on curriculum, research projects and more.

Jumpstarting Research at the Centers: As per a 2016 modification of the Cooperative Agreement, NUST and UET Peshawar were required to award 15 applied research projects and five joint research projects.

ASU worked extensively with faculty and students at the centers in promoting applied research through student and faculty exchange, visits of ASU faculty to Pakistan, and support for the design and implementation of joint research projects. During exchange visits, students selected research areas based on current projects in ASU and OSU faculty labs. This provided them exposure to research methodology and a chance to work on the latest high-end equipment. The students were also required to submit a final report at the end of the exchange. Many students had the chance to work on cutting-edge research at ASU; this led to joint journal publications and conference papers.

Research Policy: ASU assisted NUST and UET Peshawar in the development of a research policy. This policy was instrumental in the identification of relevant themes such as renewable energy, industrial process optimization, energy conservation, thermal energy and energy policy.

Research Evaluation Committees (REC): NUST and UET Peshawar established research evaluation committees for the assessment and award of projects and subsequently for review and closure. ASU participated in all REC meetings held during the project. Depending upon the nature of the proposals and project reviews, ASU faculty and staff joined the discussions either in person or via Skype. ASU's input played a vital role in awarding the projects and later in the review and completion of them.

Joint Research Projects: As per the Cooperative Agreement, USPCAS-E agreed to conduct 10 joint research projects with NUST and UET Peshawar (five with each institution). ASU and OSU faculty, together with colleagues at NUST and UET Peshawar, implemented 12 joint research projects, exceeding the project target. There were two calls for joint research proposals, and ASU took the lead in the theme selection and drafting of proposals. To ensure consistent focus in the proposals submitted for consideration, ASU identified four primary areas for research: electric systems, thermal energy, renewable and alternative energy, and policy. ASU faculty reviewed and selected projects. These joint research projects resulted in the development of many policy papers that were shared with Pakistani Energy Authorities for future planning in the energy sector.

ASU-NUST joint research projects

Project title		NUST faculty	ASU/OSU faculty
1	Smart Condition Monitoring based Design and Development of Solar Microgrid – Community Empowerment through Access to Energy in the Rural Areas of Pakistan	Dr. Syed Raza Kazmi	Dr. Govindasamy Tamizhmani
2	Development of Hybrid Micro Combined Heat & Power System for Distributed Generation in Pakistan	Dr. M Zubair	Dr. Brian M. Fronk
3	Developing the Strategy for policy-oriented energy research modeling at USPCAS-E	Dr. Kafait Ullah	Dr. Clark A. Miller
4	Energy Efficiency Improvements in Building Sector of Pakistan	Dr. Muhammad Bilal Sajid	Dr. Harvey Bryan
5	Solar space Heating Systems Integrated with Thermal Energy Storage	Dr. Majid Ali	Dr. A. M. Kannan
6	Pseudo-Noise based Impedance Spectroscopy for Battery Health Monitoring	Dr. Khawaja Arsalan	Dr. Bertan Bakkaloglu

ASU-UET Peshawar joint research projects

Project title		UET faculty	ASU/OSU faculty
1	Social and Hydrological Research to Improve Impact of Distributed Energy on Sustainable Development and Poverty Alleviation in Khyber Pakhtunkhwa	Dr. Tanvir Ahmad	Dr. Clark Miller Dr. Kendra Sharp
2	Transformer Predictive Maintenance	Dr. Basit Ali	Dr. Anamitra Pal
3	Hybrid Energy Test-Bed for Remote Communities: Integration of PV, Biomass Generator and Microhydro Generator	Dr. Shoaib Khalid	Dr. Brian Fronk

ASU-UET Peshawar joint research projects

Project title	UET faculty	ASU/OSU faculty
4 Hybrid Energy Test-Bed for Remote Communities: Energy Generation from Biomass	Dr. Qari Khalid	Dr. Brian Fronk
5 Anti-Soiling Coating for Quaid-e-Azam Solar Power PV Modules	Dr. Saim Saher	Dr. Govindasamy Tamizhmani
6 National Energy Modeling Strategy for Pakistan and KP province	Dr. Irfan Mufti	Dr. Clark Miller

All joint research projects were successfully closed in the fourth quarter of fiscal year 2019. ASU faculty took the lead and guided their Pakistani counterparts throughout the project. Regular in-person or Skype meetings were held with Pakistani faculty to share the progress and also to guide them as needed. The research outputs of the projects were outstanding, and the faculty published their findings in impact factor journals. The experience was pivotal for Pakistani faculty in learning to successfully manage joint research projects with a foreign university. This example of research collaboration between U.S. and Pakistani universities provides an excellent model that can be replicated in future initiatives.

IMPACT

NUST students and faculty produced 150+ publications and UET Peshawar faculty and students produced 60+ publications.

Students accustomed to 24/7 access to labs in the U.S. as exchange scholars pushed for an increase in lab access and training upon their return, which resulted in improved access for students and better training on all lab equipment.

Applied Research Projects: NUST awarded 15 applied research projects. This required the review of more than 200 proposals from NUST faculty and other universities. On the first call for proposals, NUST received more than 100 proposals for funding. However, after an extensive review by ASU and NUST faculty, only four were awarded. The same rigor was maintained throughout the project for the award of the remaining 11 projects. ASU reviewed the shortlisted proposals and provided feedback. Later the shortlisted proposals were presented in Research Evaluation Committee (REC) meetings for further review by faculty and industry representatives. ASU faculty and staff also participated in the REC meetings in-person and via Skype. This thorough review process resulted in the selection of high-quality applied research projects.



ASU also supported the technical implementation of the applied research projects.

UET Peshawar awarded 22 local applied research projects and conducted the following local applied research projects with the support of ASU. This support included the evaluation of a large number of submitted proposals and finalizing the awardees. ASU also supported the technical implementation of the local applied research projects.

▼ NUST Applied Research Projects

Title of project	Name of PI
Valorization of biomass residues for methane production through anaerobic digestion technology: Green energy recovery from waste	Dr. Rabia Liaquat
Solar Power integration of 2-KW into main grid by using Dual-Mode power converter	Dr. Hammad Iqbal Sherazi
Simulation Modeling, Analysis and Forecasting of Electricity generation and consumption in Pakistan using System Dynamics approach	Dr. Imran Mahmood
Liquid fuel production from Coal/Biomass derived Syngas	Dr. Naseem Iqbal
Conversion Kit for UPS to a pseudo-hybrid converter with scalable architecture for neighborhood level distribution capability	Dr. Hassan Abbas Khan
Smart Load Enabler for Micro-Grids in Pakistan	Dr. Ammar Hassan
Development of Advanced Metering Infrastructure & Customer Side Systems	Dr. S. Sajjad Haider Zaidi
Development of Self Cleaning and Low Emissivity thin films for glass	Dr. M. Mujahid
Double perovskite based multiferroic materials for solar cell applications	Dr. M Yaseen/Dr Sofia Javed
Indigenous Design and Development of a Solar Powered Adsorption Refrigerator (SPAR)	Dr. Taqi Ahmad Cheema
DC Module to Improve the Efficiency of String Inverter Solar PV System	Dr. Husein Najmi
An Advance Rotor for H-Darrieus Type Vertical Axis Wind Turbine (VAWT)	Dr. Adeel Javed
Autonomous 11kV Distribution Line Fault Localization System	Dr. Khawaja Arsalan Habib
Designing and Fabrication of Semi-Continuous Stirring Tank Reactors to Evaluate and Optimize the Anaerobic Co-Digestion of Poultry Manure	Dr. Muhammad Hassan
Pseudo-Noise based Impedance Spectroscopy for Battery Health Monitoring	Dr. Khawaja Arsalan Habib

▼ UET Peshawar Applied Research Projects

Title of project	Name of PI
Development of a Large Capacity Solar-Biomass Hybrid Tunnel Dryer in Swat for Long Term Preservation of Fruit Including Persimmon	Dr. Suhail Zaki
Intelligent Controller for Economic Load Dispatch in Microgrids	Dr. Naeem Arbab
Real Time Monitoring of Distribution Transformers	Dr. Abdul Basit
360 Sun Tracking and Auto Cleaning System for Solar Array	Dr. Tanvir Ahmad
A more efficient and reliable Solar Energy System for residential and commercial applications	Dr. Zaka Ullah
Synthesis of nanofluid to improve the thermal and dielectric breakdown strength of transformer oil	Dr. Saim Saher
Parametric Analysis of Solar Photovoltaic Cell	Dr. Alam Zaib
Reduction of Heat Losses from Cement Kilns by Using a Low Emissivity Paint	Dr. Alam Zaib
Fuel and Electricity theft detection and reporting using wireless sensor networks	Dr. Gul Muhammad
Design, Modeling and Assessment of Phase Change Materials (PCM) Based Energy Efficient Prototype Building	Dr. Khan Shahzada
Design and fabrication of double loop solar water heater coupled with heat storage materials	Dr. Khurshid Ahmad
Design and Development of Electronic Load Controller	Engr. Muhammad Saeed
Heat Recovery from Exhaust Fuel Gases	Engr. Asif Sultan
Variable Frequency Air Conditioner Compressor Drive	Dr. Musharraf Ahmed Hanif
Traversing the Path Towards Next Generation Electrical Transportation in Pakistan- Models and Scenarios	Dr. Naveed Arshad
Data Communicator for Grid Control System (DCGCS)	Dr. Zubair Ahmad Khan

RESEARCH ACCOMPLISHMENTS

✓ fostered a culture of research

✓ **36** applied research projects completed

✓ **12** joint research projects completed

✓ **16** labs established

4 EXCHANGE PROGRAMS

The center supported the academic and research advancement of students and faculty by hosting students and faculty in the United States to conduct cutting-edge energy research in state-of-the-art labs and facilitate learning and professional development through exchange programs. These exchange programs enabled students and faculty members from NUST and UET Peshawar to spend a semester at ASU or OSU.

Exchange objectives	
4.1	Develop graduate and post-graduate short-term training and exchange programs at ASU for students and faculty
4.2	Organize workshops and exchanges at partner universities to institutionalize the use of effective, experiential teaching techniques at the graduate level that promote critical thinking

EXCHANGE PROGRAM

Under this component, ASU created an exchange program to train more than 200 exchange visitors (EVs) in U.S.-based labs and offered 14 thematic and technical workshops in Pakistan. In January 2016, Arizona State University welcomed 24 exchange graduate students, the first of seven cohorts. In all, 217 graduate students and faculty visited the U.S. for semester-long exchange programs surpassing the original Cooperative Agreement target of 50 (which was later revised to 100 and then revised again to 200) exchange scholars.

The exchange program focused on providing research training for students and faculty from NUST and UET Peshawar. Workshops and seminars allowed students and faculty who were unable to be part of the exchange program the opportunity to participate in knowledge exchange with U.S.-based experts.

Students and faculty members from NUST and UET Peshawar spent 16 weeks at ASU or OSU. Through this immersive exchange program, exchange scholars received hands-on research training, professional development and opportunities to foster cross-cultural understanding. Scholars developed leadership skills to prepare them to play integral roles in bringing Pakistan to the forefront of energy engineering and policy.

RESEARCH TRAINING

Exchange scholars were assigned to one of seven areas as part of their research training. Students received hands-on experience operating lab equipment and transferring their classroom learning to implementation and original research.

PROFESSIONAL DEVELOPMENT

The scholars placed at ASU participated in two semester-long classes: Energy Policy and Technology Entrepreneurship. Through these sessions, they learned about policymaking in energy and identified policy initiatives for Pakistan. In the entrepreneurship class, scholars learned how to become job creators and apply their graduate research into tangible solutions for Pakistan. OSU-based scholars also had the opportunity to participate in ASU's energy policy sessions online and also attended an energy engineering seminar series.

The scholars had opportunities for professional development through networking events, skill-building seminars and group presentations in their respective labs.

BUILDING CROSS-CULTURAL UNDERSTANDING

Through planned excursions, exchange scholars were exposed to both industry and cultural sites. Industry visits allowed scholars to learn about U.S. energy supply and production, while cultural outings introduced them to a cross-section of American society. Through these visits and trips, scholars learned from and shared with others, facilitating an exchange of knowledge and deepening the understanding between Americans and Pakistanis.

USPCAS-E COMMITMENT TO SCHOLAR SUCCESS

Each scholar received supervision from a faculty member. Staff check-ins with scholars offered an opportunity to review faculty assessments and to ensure that each scholar was performing well. Staff met with each scholar individually to conduct a midterm review, looking back at their performance to date and also making sure the student was adjusting to life at ASU or OSU and in the United States.

HANDS-ON TRAINING

The exchange visitors became change agents for lab access and hands-on training at their home universities. Before the exchange program, students reported limited access to equipment to run their experiments at their universities. Much of their education revolved around lecture-based learning. After spending a semester at ASU or OSU, exchange scholars gained hands-on training on a wide range of equipment, and they wanted to continue that training at their home universities.

Based on exchange scholar evaluations, 91 percent of scholars in the seventh cohort reported a high level of satisfaction that their lab training “encouraged them to develop abilities to use technology in relevant ways to their practice.” The students became catalysts, pushing the centers at their home universities to increase student access to labs, institute training on all equipment and develop standard operating procedures (SOPs) for lab safety.

SOFT SKILLS AND PROFESSIONAL DEVELOPMENT

The exchange program placed an emphasis on soft skills and professional development. This included hosting sessions such as curriculum vitae preparation at ASU or attending Toastmasters classes in public speaking at OSU. Scholars also had the opportunity to participate in conferences recommended by their host faculty as part of their training implementation plans. The table below shows the reported level of improvement in soft skills among the scholars of cohort seven (spring 2019).

▼ Level of improvement among exchange visitors regarding soft skills

	No change	Slightly improved	Highly improved
Confidence to communicate with faculty and other students	3	8	89
Problem solving skills	0	32	68
Presentation skills	3	19	78
Interaction/socialization	0	19	81

CROSS-CULTURAL EXCHANGE AND INDUSTRY VISITS

Because the scholars came to the United States on a J-1 exchange program, ASU made cross-cultural and industry exchanges an integral part of the program. This included cultural visits to iconic American experiences such as the Grand Canyon to learn about Native Americans, conservation and tourism. The scholars also visited sites like the Bonneville Dam to learn about hydropower and energy policy in the United States. Equally important, scholars had opportunities to share their culture and knowledge with Americans and other international visitors in the United States. For example, scholars at ASU participated in events such as Open Door, a community event showcasing ASU research initiatives, to talk about USPCAS-E with the public while also sharing their culture through personal stories and traditional attire.

IMPACT

In spring 2019, 94% of cohort seven scholars reported high satisfaction levels that cultural excursion provided meaningful knowledge in understanding U.S. culture; 85% of scholars reported high satisfaction levels that they were given opportunities to share their culture with U.S. citizens; and 88% reported high satisfaction levels with industry visits and the relevance to their academic background.

WORKSHOPS AND VIRTUAL SEMINARS

Throughout the life of the project, ASU committed to offering 10 thematic and technical workshops for NUST and UET Peshawar. The thematic workshops allowed for the exchange of knowledge and brainstorming in areas of energy research needed in Pakistan. In all, 14 workshops were delivered, exceeding the Cooperative Agreement target. These 16-hour workshops delivered in Pakistan by U.S.-based experts were open to all.

Trainings for partner faculty and staff were organized to increase technical expertise critical to the long-term sustainability of the centers, including Technical Proposal Writing facilitated by proposal writing expert Mr. Alan Paul; and Corporate Engagement, delivered by industry engagement expert Mr. Lou Farina. Both workshops drew attendees from both partner universities and a large number of stakeholders.

Linking UET Peshawar and NUST with various government and private institutions for collaboration, including the Higher Education Commission, contributed to sustainability efforts. ASU hosted a Leadership in Higher Education training in Islamabad March 18-22, 2019. The training was led by Dr. Dan Shunk, an ASU professor and leadership expert and consultant. The training was attended by 44 participants (including six female participants) from NUST and UET Peshawar. The first two days were for all participants, followed by one day each for UET Peshawar and NUST staff to discuss their specific sustainability plans.

On July 11, 2018, Dr. Clark Miller from ASU conducted a one-day session on Energy Poverty that was attended by 64 participants (including 14 female participants) from NUST, UET Peshawar and civil society organizations involved in energy poverty initiatives. Dr. Miller has done extensive research on the energy-poverty nexus, which he shared in the context of Pakistan's energy landscape. He also shared a framework that emphasizes a compound measurement of the quality and quantity of energy provision, and a social value of energy tool, which measures how much value an energy user can derive from the use of energy.

▼ Technical workshops

Workshop title		Presenter	Year
1	Renewable Energy, PV System	Dr. Sayfe Kiaei	2015
2	Energy Policy and Leadership	Dr. Clark Miller	2016
3	Batteries and Fuel Cells	Dr. Arunachala Mada Kannan	2016
4	Green Buildings	Dr. Harvey Bryan	2016
5	Gender	Dr. Chad Haines	2017
6	PV Certification and Reliability	Dr. Govindasamy Tamizhmani	2017
7	Technology Entrepreneurship	Mr. Kenneth Mulligan	2017
8	Strategic Proposal Development Workshop	Mr. Alan Paul	2018
9	Energy Materials: Research Opportunities in Photovoltaics	Dr. Zachary Holman	2018
10	Corporate Engagement	Mr. Lou Farina	2018
11	Hydro Power	Dr. Kendra Sharp	2018
12	Leadership Training	Dr. Dan Shunk	2019
13	Pedagogy Training	Dr. Peter Rillero	2019
14	Technology Center Training	Mr. Bulent Bicer	2019

In addition to thematic workshops and other trainings, ASU offered a virtual seminar series for students and faculty at NUST and UET Peshawar. These virtual seminars allowed faculty and students to learn about current energy research in one of the 12 labs offered through the exchange program at ASU or OSU. The seminars helped in reaching out to a larger number of students, including students from other schools, and stakeholders as well.

▼ Virtual seminars

Workshop title		Presenter	Year
1	Multi-disciplinary research work: Freedom Project	Dr. George Karady	Nov. 2016
2	Hydrogen Economy: Problems and Prospects	Dr. Arunachala Mada Kannan	Feb. 2017
3	Recent Advances in High Temperature Solar Thermal Power Generation	Dr. Brian Fronk	May 2017
4	Where will solar go next?	Dr. Zachary Holman	Sept. 2017
5	Solar Photovoltaics – Testing and Certification	Dr. Govindasamy Tamizhmani	Dec. 2017
6	The Social Drivers, Dynamics, and Outcomes of Energy Innovation	Dr. Clark Miller	March 2018
7	Technical Issues in Thermal Power Generation, and How You Can Solve Them	Dr. T. W. Lee	Sept. 2018
8	Entrepreneurial Mindset	Mr. Kenneth Mulligan	Dec. 2018
9	Use of Hydropower Assessment Tool (HPAT) for Small Hydro	Dr. Kendra Sharp	April 2019

EXCHANGE ACCOMPLISHMENTS

✓ **217** exchange scholars

✓ **9** virtual seminars
offered by ASU and OSU faculty

✓ **14** thematic and technical workshops
hosted by ASU in Pakistan and facilitated by industry experts

✓ **4** specialized trainings
on energy poverty, pedagogy, Technology Center implementation and online program development

5 SUSTAINABILITY

USPCAS-E worked to ensure the long-term viability of the centers by focusing on financial sustainability. Through fundraising strategies and the cultivation of public-private partnerships, the centers looked beyond quick wins to build a foundation for transformational change and long-lasting prosperity.

The Centers for Advanced Studies (CAS) project was designed by USAID and the Higher Education Commission of Pakistan (HEC) to support Pakistan's economic development by strengthening the relevance and responsiveness of university products—including applied and policy research and skilled graduates—to the needs of the public and private sector.

The ultimate goal was to make these funded centers financially viable past the funded project.

USPCAS-E worked to achieve this through research grants, fundraising and public-private partnerships. Stakeholder engagement with Pakistan's higher education institutions is believed to be key to private-sector innovations, promoting modernization, strengthening government policy and stimulating economic growth. Active participation of the energy sector was facilitated through national stakeholder meetings and frequent one-on-one meetings.

Exchange objectives

5.1	Increase the capacity of each center and its host university to raise funds from alumni, grantmaking foundations and the private sector
5.2	Build the capacity of the centers to reach out to the business community and other private sector stakeholders to establish productive dialogue, promote their research services, and market the skills and qualifications of their graduates
5.3	Develop and implement a robust program of sustainable and long-term collaborative linkage between ASU and its partners

The following capacity-building efforts were made to help the centers become financially sustainable:

1. ASU engaged a full-time corporate engagement specialist to lead energy industry engagement strategies.
2. ASU led stakeholder engagement activities on behalf of its partners. It hosted six stakeholder meetings with 472 participants from stakeholders and industry.

3. ASU organized the following workshops for its partners to build their capacity in the area of sustainability:
 - a. Strategic Planning
 - b. Corporate Engagement
 - c. Proposal Writing
 - d. Leadership
5. ASU supported both centers in the development and implementation of their individual sustainability plans.
6. With the support of ASU, NUST and UET Peshawar developed written plans for industry engagement and implemented them.

ASU has provided the following support to the partner universities:

STAKEHOLDER ENGAGEMENT

ASU hosted six stakeholder meetings during the project. The meetings were attended by federal and provincial institutions (including Ministry of Water and Power, NTDC, Energy Departments), energy utilities (including IESCO, KESC, PESCO), energy industry (including Three Gorges Dams, Attock Gen, Star Hydro), bilateral and multilateral donors (including KfW, AfD, The World Bank), academia (including UET Lahore) and civil society (including PPAF, SRSP, AKRSP).

The objective of these meetings was to align the centers' research and curriculum with the needs of the energy sector, solicit input on policy matters, and engage stakeholders in other sustainability efforts of the centers.

Summary of participation in stakeholder meetings

S#	Date	Venue	Male	Female	Total
1	Feb. 29, 2016	NUST Islamabad	21	1	22
2	Dec. 15, 2016	Serena Hotel Islamabad	51	4	55
3	Oct. 5, 2017	Serena Hotel Islamabad	79	7	86
4	April 25, 2018	Serena Hotel Islamabad	109	13	122
5	Nov. 14, 2018	USPCAS-E NUST Islamabad	83	11	94
6	Sept. 24, 2019	USPCAS-E NUST Islamabad	80	13	93
Total (duplication reported)			423	49	472

INDUSTRIAL LIAISON

To keep energy sector partners in Pakistan informed about USPCAS-E activities and to develop partnerships, ASU facilitated more than 100 one-on-one meetings between energy sector organizations and USPCAS-E faculty and the project management units. As a result, NUST developed seven MoUs for public-private partnerships, and UET Peshawar created six MoUs for public-private partnerships during the life of the project. These partnerships will enable the centers to continue working with the government and private sector beyond project life.

CAPACITY BUILDING

ASU supported its partner universities in developing and finalizing their own sustainability plans. ASU provided annual reviews of the implementation status of NUST and UET Peshawar's sustainability plans. The following workshops specifically supported capacity-building efforts:

Facilitator	Organization	Workshop topic	Date
Sayfe Kiaei	ASU	Strategic Planning	March 2016
Alan Paul	Giant Angstrom	Proposal Writing	Feb. 2018
Lou Farina	Windmill Ridge Ventures	Corporate Engagement	April 2018
Dan Shunk	ASU	Leadership Training	March 2019

INTERNSHIPS

Partner universities had a target to secure 50 internships each during the life of the project. ASU supported NUST and UET Peshawar in securing 121 internships in different energy sector organizations.

Number of internships	Target	Total
NUST	50	71
UET	50	50
Total	100	121

[Click to see the Annex on student internships for more details](#)



INDUSTRIAL VISITS

ASU supported its partner universities in 51 industrial visits to key energy sector organizations. The objective of these visits was to help students understand industrial practices, observe the application of the theoretical knowledge they were learning in the classroom, identify potential research areas and topics, and explore possible careers.

Click to see **Annex** on **industrial visits**

LOCAL SEMINARS

ASU facilitated local seminars on current developments and challenges of energy sector leaders to keep the faculty and students abreast of the latest trends in the sector. ASU facilitated 21 seminars with industry experts.

THINK TANK

It was envisioned that each CAS would develop relevant policy dialogues and reforms for each technical sector. ASU developed a concept note on the framework of the Energy Think Tank at USPCAS-E and worked with NUST and UET Peshawar to make the Think Tanks dialogues a reality. Both centers have Energy Think Tank working groups in place. NUST held two policy dialogues and UET Peshawar hosted five policy dialogues during the project.

TECHNOLOGY CENTER

Pakistan's solar industry is facing a huge skills gap and requires experienced workers who can ensure customer satisfaction through quality design and installations. USPCAS-E at NUST and UET Peshawar are partnering with 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 and 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; and workforce skills and competency training on the design, installation, operation and maintenance of PV systems.

Both Technology Centers are equipped with unique, state-of-the-art tools and equipment to enable offering the services mentioned above. These Technology Centers provide a source of income for the partner universities by offering unique photovoltaic training programs and testing services that address unmet needs in Pakistan. These centers and their equipment can also be leveraged for research and teaching purposes by faculty and students at NUST and UET Peshawar.

Both NUST and UET Peshawar are committing classroom and lab resources as well as key personnel. These staff members visited ASU for hands-on training at the Photovoltaic Reliability Laboratory (ASU-PRL) at ASU's Polytechnic campus, a lab headed by Govindasamy "Mani" Tamizhmani. The three-week training at ASU-PRL focused on providing the Technology Center staff from NUST and UET Peshawar with the fundamental knowledge for conducting PV module qualification testing activities required by the IEC 61215 standard.

ASU also conducted a five-day train-the-trainer workshop in Islamabad at NUST for center faculty and staff as well as 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.

These Technology Center activities went above and beyond the scope of the Cooperative Agreement.

SUSTAINABLE PARTNERSHIP WITH PARTNER UNIVERSITIES

NUST and UET Peshawar have approached ASU about continuing their partnership. ASU hosted four visits for NUST leadership in FY15, FY16, FY18 and FY19. ASU and the partner universities are discussing options that include a joint Ph.D. program under the Higher Education Commission's Knowledge Corridor project. ASU facilitated two visits of UET Peshawar leadership to ASU in FY15 and FY19, and joint degree programs are under discussion between ASU and UET Peshawar.

SUSTAINABILITY ACCOMPLISHMENTS

✓ FUNDRAISING:

The centers have raised **\$2.2 million** through their fundraising efforts. NUST raised **\$1,251,158** and UET Peshawar raised **\$1,058,080** through a variety of public and private sources.

➤ Click to see the **Annex** on **funding sources**

✓ INTERNSHIPS:

ASU supported its partners to identify **121 placements**: 71 for NUST and 50 for UET Peshawar.

✓ TECHNOLOGY CENTERS CREATED AND STAFF TRAINED:

NUST and UET **developed business plans**; key staff attended a **two-week hands-on training** at the Photovoltaic Reliability Laboratory (PRL) at ASU; ASU also development lab accreditation manuals and offered hands-on training in Pakistan.

✓ ENERGY PLAN FOR PAKISTAN

Working with energy research institutions across Pakistan to identify current strengths and capacities, ASU developed a draft energy research agenda and then brought together representatives for a consultative session to discuss the need for an integrated research agenda.

➤ Click to see the **Annex** for the **energy plan**

✓ MOUS:

ASU led the outreach efforts with **more than 100 visits** to energy sector partners. As a result of these meetings, NUST developed **seven MoUs** for public-private partnerships, and UET Peshawar has created **six MoUs** for public-private partnerships.

✓ INDUSTRIAL VISITS:

ASU facilitated **51 industrial visits** for students at NUST and UET Peshawar.





Noman Khan



Engineering has not only changed me and my life for the better, but it has also changed our collective lives in this country.



Noman Khan has a laser focus when it comes to 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.

"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."

SECTION

2

LESSONS
LEARNED

We are proud of the many accomplishments of the USPCAS-E project. We were able to outperform agreed-upon targets in several areas. There are several lessons learned along the way that we present here for future consideration when developing similar projects.

COOPERATIVE AGREEMENT

Each of the three partners had separate Cooperative Agreements. This created confusion, and it facilitated different agendas and work plans instead of a unified mission and vision. There was a missed opportunity to leverage the efforts of all three partners toward common goals and to avoid siloed activities. The USPCAS-E partners did sign a four-way memorandum of understanding, but unfortunately, it came too late in the project life to have the maximum beneficial impact.

Some of the Cooperative Agreement goals could not reasonably be met, given the project timeline and the existing conditions. For example, hoping for gender parity in a field where women are underrepresented across the globe was, in hindsight, not a reasonable expectation. Compounding the conditions of the engineering field were societal conditions that keep women from educational opportunities or poorly prepare them for academically rigorous programs like engineering. Having a third party evaluate the targets against available data may have helped avoid targets that were not achievable.

Reviewing the Cooperative Agreement with all partners, including HEC and USAID, in advance of the project start date and coming to an agreement on partner responsibilities related to each deliverable, including a timeline, would have gone a long way to avoiding misunderstanding and lost time in executing the project work plan. Also, ensuring that each partner was positioned to carry out the work plan deliverables, including fully functional project management units, recruitment, gender equity planning and implementation, and faculty hiring would have created optimal conditions for success.

PROJECT MANAGEMENT UNITS (PMUS)

The Project Management Units (PMUs) at each school needed to be in place and functioning prior to the project start date. To do otherwise is akin to driving the bus while you are still building it. Particularly at UET Peshawar, the lack of a fully functional PMU significantly impeded project progress. The PMUs needed to be a precondition of project award.

STRATEGIC PLANNING

Creating a strategic plan with a clear roadmap and an outline of work plan activities for each partner should have been done at the beginning of the project. This could have included a market analysis for degree programs, enrollment potential, recruitment of faculty, and the job market for internship placement and hiring of graduates. Identifying potential industry and government stakeholders and partnerships, (as well as potential donors), and involving them from the beginning, would have accelerated buy-in and also helped to jumpstart research and fundraising activities.

RETHINKING THE PROJECT WRAP-UP PERIOD

Creating a more extended grace period after the official project end date for wrap-up activities, including travel and closing activities, final invoicing and reporting activities, would facilitate a smoother wrap-up of project activities. There was a hard stop that seemed to unnecessarily rush these prescribed activities and may have hindered a seamless handoff of the centers.

IMPROVING PROJECT COMMUNICATIONS

Working among different agencies and institutions inevitably presents bureaucratic challenges. Each organization comes to the table with a different culture and different expectations. Addressing communications standards and expectations up front and coming to a shared understanding of points of contact, governance, approvals and related timelines would have helped alleviate frustration and improved project effectiveness and efficiency.

[Click to see the Annex on recommendations](#)



Zeeshan Saeed Shah



The most important experience was my exchange visit to Arizona State University.



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.

“This drew me towards entrepreneurship.”

SECTION

3

AN ASSESSMENT OF PERFORMANCE UNDER THE COOPERATIVE AGREEMENT

ACTIVITY MONITORING, EVALUATION AND LEARNING PLAN

A comprehensive Activity Monitoring, Evaluation and Learning (AMEL) plan was developed at an early stage of the project, and then extensively revised in 2017 with approval from USAID. The AMEL plan describes the process and framework by which Arizona State University's project team monitored, evaluated, analyzed and reported progress and results for the U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E) project. The AMEL framework for monitoring and evaluation identified changes in project implementation, detected obstacles constraining progress and leveraged data to inform ongoing project-management decisions. It also created a process to measure relevant performance indicators and impacts of the project to determine the extent to which objectives were being met during the program and at completion.

AMEL SYSTEMS AND APPROACHES

The AMEL system and related mechanisms were developed and implemented in consultation with the project team, NUST's and UET Peshawar's Monitoring and Evaluation (M&E) teams, as well as with USAID. Throughout the project implementation, data reported met the USAID quality standards and requirements and provided timely feedback to the project team and senior management for necessary course corrections.

The ASU M&E Specialist worked closely with the M&E teams at both partner universities to ensure that there was no duplication of effort in reporting and that all joint activities used a combined M&E approach, strengthening their capacity. The M&E specialist also worked closely with the USAID team to understand the reporting requirements, data quality standards and facilitated Data Quality Assessment (DQA).

Standardized data collection tools and approaches were developed and implemented by considering AMEL plan indicator needs, the information required for decision making and the need for gender-disaggregated data wherever applicable for analysis and feedback. Component-specific details are provided below:

GOVERNANCE

Under the Governance component, ASU provided support to partner universities in establishing various committees and working groups such as the steering committee, curriculum working group and research committees. ASU worked continuously with NUST and UET Peshawar to launch these forums and actively participated in the meetings. As per reporting requirements, ASU documented its support through email and followed up on all decisions made during meetings. In close coordination with UET Peshawar and NUST, ASU agreed to collect meeting minutes and share the records of these meetings on a quarterly basis.

Similarly, ASU developed a comprehensive self-assessment tool for partner universities to evaluate and understand the overall quality of their work and identify areas for improvement. It also provided a systematic process and basis for comparing perceptions and the understanding of various stakeholders and in identifying outcomes; it strengthened communication among stakeholders; and it helped build a collective vision of the desired results and a plan to achieve them. NUST modified this tool and combined it with HEC tools of assessment for its use. UET Peshawar used the same tool to conduct a comprehensive evaluation. The ASU team reviewed these self-assessment reports and provided recommendations.

CURRICULUM

At the early stages of the project, it was difficult to track the process of curriculum development and review. Therefore, after having a series of meetings and consultation, ASU developed a curriculum tracker. The tracker captured essential details such as the dates that working papers were prepared, frequency of reviews, faculty reviews and whether programs were offered or not. The UET Peshawar and NUST M&E teams were briefed on this tracker, and they subsequently collected and consolidated information using this tool. This not only brought the entire curriculum process into one place, it also helped teams to complete missing evidences. Also, ASU's M&E specialist visited NUST and UET Peshawar on multiple occasions to answer questions and persuade partner university faculty to provide the necessary information.

APPLIED JOINT RESEARCH PROJECTS

Under this component, ASU led the joint research projects. The complex, multi-national nature of joint research projects created several challenges in tracking project progress, collecting evidences and reporting. To ensure that the proper documentation was in place, a minimum documentation requirement as per USAID data quality standards was defined and evidences collected accordingly. These evidences included:

- The final and approved proposals
- Award letters of ASU, UET Peshawar and NUST faculty
- Emails providing no-cost extensions
- Quarterly/semi-annual reviews
- Final reviews
- Final/closeout reports

ASU developed a comprehensive template and the related guidelines for quarterly reviews of joint research projects and shared these with UET Peshawar and NUST for their input and implementation. This template included key information about the project; quarterly key performance variables as per the approved proposal; progress against KPIs, including any deviation; and any other information. The quarterly reviews were led by the technical advisor and research lead based on the completed template and faculty presentations. The ASU technical team added their feedback and shared this with relevant faculty. Final reviews were conducted by ASU's technical advisor and research lead.

The ASU team, in close consultation with UET Peshawar and NUST's M&E staff, developed a comprehensive final closeout report template and guidelines for successful closure of joint research projects. These templates were shared with the partner universities and onward shared with faculty before each research project's end date. ASU reviewed reports and provided feedback multiple times before the project was closed. The final reports were signed by faculty of ASU, NUST and UET Peshawar; reviewed by the technical advisor and research lead; and approved by the project director.

A faculty interaction template was also used to document meetings between ASU faculty and NUST and UET Peshawar faculty for joint research projects.

EXCHANGE PROGRAM AND WORKSHOPS

Throughout the project life, a comprehensive AMEL approach was implemented for various activities in the exchange and workshop program.

Multiple data collection and reporting tools were developed and implemented to track and assess exchange visitors' progress during the exchange program. These tools included events and excursions with documentation showing participation of the exchange visitors, activities carried out

during events and excursions, evaluations with participant feedback and suggestions for further improvement; project presentations by students; and reflections and feedback on the overall exchange program (including selection, logistics, the visa process, accommodation and support provided during their stay). The completion certificate provided to participants at the end of the exchange program signified the successful completion of the program and also met USAID requirements for reporting as per Mission Strategic Framework Indicator.

To assess the satisfaction of exchange visitors, an exit survey was given to all students and faculty. Two separate survey questionnaires were administered based on the participation of students and faculty in various activities. The student questionnaire used Likert scales to assess student satisfaction with multiple components of the exchange program, such as support provided before, during and after the exchange program. It also evaluated feedback on various events organized during the exchange visit, such as cultural activities, courses and industry visits. One of the main objectives of the exchange program was to enhance soft skills such as communication, presenting and problem-solving. Therefore, students were also asked to rate improvement in these areas as a result of their participation. Exchange students also completed survey questionnaires, and the data was entered into an Excel database for analysis.

ASU planned and organized 14 technical and thematic workshops. These workshops had significant impact on participants' knowledge and learning. In order to capture the required details, USAID reporting requirements and participants' feedback, standardized data collection tools were developed and implemented. These tools included:

- Workshop agenda – Outlines the entire workshop program with dates, times and speakers
- Participant registration – Name, age, designation and organizational affiliation
- Attendance sheet – Track attendance to provides a basis for participation and completion
- Participant feedback – Developed and used at the end of each technical and thematic workshop. The data collected on these forms was used to identify areas for improvement and assess participant satisfaction in various areas such as logistical arrangements, instructional methodology and content, facilitator/s support, time management, and overall satisfaction and usefulness of workshop
- Workshop report – The report template provides guidelines on collecting and reporting content, including basic information about the workshop, objectives, facilitator observations, feedback analysis, key suggestions and recommendations

SUSTAINABILITY

Project sustainability efforts were initiated in the third year of the project and continued until the project's end. ASU was primarily responsible for holding stakeholder meetings twice a year, identifying stakeholders, organizing meetings between various stakeholders and partner universities, identifying funding opportunities and internships, and assisting partner universities in arranging industrial visits.

Also, an Excel matrix was developed and populated with information including the name of the organization, type of organization (industry, government, private, academia), meeting frequency, the purpose of the meeting and outcomes.

During the stakeholder meetings, comprehensive feedback was collected, analyzed and incorporated into a meeting report. Depending on the final agenda, a relevant feedback questionnaire was designed and used. This feedback provided useful information to ASU and the partner universities to improve their support for stakeholders, align curricula to market needs, refine research, and identify opportunities for students and faculty.

ASU SELF-ASSESSMENT STUDY – MEASURING STAKEHOLDERS SATISFACTION UNDER ALL COMPONENTS

In addition to regular monitoring and data-tracking activities, ASU also designed and carried out a study with the assistance of an external consultant. The main objective of this study was to assess the success of the project in achieving the desired results and to gauge the satisfaction of the project stakeholders.

Support by ASU to the two centers was provided in five key component areas: governance, curriculum development and reform, exchange and scholarship programs, research, and sustainability. The study evaluated the project on five parameters: relevance, timeliness, quality, efficiency and the sustainability of the interventions. The study used all types of stakeholder observations to analyze the quality of work done by ASU.

The results of this study indicate that the support provided by ASU in all key areas was successful and highly effective. The relevance, timeliness, quality, efficiency and sustainability were measured on a scale of 1 to 5 (5 being highest). The aggregate results show that the rating for the overall effectiveness of various parameters was rated as 4 and higher than 4.

The overall satisfaction on the adequacy of support in all five components was assessed on a scale of 1 to 3 (3 being highest). Of the 51 respondents interviewed, 78 percent rated their satisfaction at the highest level. Interestingly, although the centers are located at two different universities, 200

kilometers apart, and in two different socio-political contexts, respondents rated the support at almost the same levels for both, indicating that ASU had shown significant flexibility in adjusting its assistance to meet the particular needs of each center. Stakeholders also identified areas for future projects.

Click to see the **Annex** for the full **self-assessment study report**

QUARTERLY REPORTING

Based on the AMEL plan, the M&E specialist developed monitoring and evaluation systems, prepared data collection tools and templates according to USAID's five data quality standards, implemented those tools, and built the capacity of project staff to use those systems for timely reporting.

The ASU technical team used tools developed for the documentation of project activities and provided evidences for each intervention carried out throughout the project. Every quarter, the technical team finalized and shared quarterly evidences with the M&E specialist. These were reviewed, reconciled and organized in the project's Dropbox file management system. All evidences will be shared with USAID at the closeout.

Reporting on USAID Mission Strategic Framework (MSF) indicators was a regular feature of project reporting. USAID/Pakistan utilizes a management information system called PakInfo/USAID info to track major activities for mission-funded projects through assigned MSF indicators. The team reported quarterly data for several USAID MSF indicators through this information-reporting portal. ASU provided regular updates of information including, but not limited to, performance results, geospatial coordinates and photographs.



Maham Akhlaq



The exchange program contributed immensely to my academic growth as well as personal growth.



Maham Akhlaq 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.

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.”

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.

SECTION

4

PARTNERS IN
PAKISTANSTATUS REPORT ON ALL PAKISTANI INSTITUTIONS WITH WHICH
THE RECIPIENT WORKED TO A SIGNIFICANT DEGREE

- 1 Higher Education Commission (HEC)
- 2 Pakistan Council for Renewable Energy Technologies (PCRET)
- 3 Ministry of Energy
- 4 Ministry of Climate Change
- 5 Alternate Energy Development Board
- 6 Three Gorges Dams
- 7 Attock Generation Company (Attock Gen)
- 8 SAARC Energy Research Center
- 9 Oil and Gas Regulatory Authority (OGRA)
- 10 Institute of Public Policy

HIGHER EDUCATION COMMISSION:

ASU has worked with HEC since the beginning of the USPCAS-E project. ASU signed a four-way memorandum of understanding (MoU) with its partners and HEC regarding the partnership framework for the USPCAS-E project. ASU is also part of the U.S.-Pakistan Knowledge Corridor Project with HEC, and participates in the National Steering Committee led by HEC for the Centers for Advanced Studies (CAS) Project. ASU supported its partners in developing proposals for HEC's Technology Development Fund (TDF), and both partners have secured TDF funding. HEC is adopting the USPCAS-E model for its plans. For example, research funding programs are being redesigned to focus on applied research issues, and new universities, like the University of Swat, are being modeled after USPCAS-E.

MINISTRY OF PLANNING AND DEVELOPMENT

ASU supported its partners in developing a partnership with the Energy Wing of the Ministry of Planning and Development, and as a result, faculty and students from NUST and UET Peshawar are part of a sector group of the team developing an integrated energy plan (IEP) for Pakistan. So far, seven students have completed IEP internships. IEP is used for long-term planning in Pakistan's energy sector. As a direct result of the IEP, the Alternative and Renewable Energy Policy and the Electric Vehicles Policy (EVP) were developed and approved by the Government of Pakistan. These policies are an important step toward a clean energy mix and the indigenous development of new energy technologies.

PAKISTAN COUNCIL FOR RENEWABLE ENERGY TECHNOLOGIES (PCRET)

ASU supported its partners in signing an MoU with PCRET. The partners have arranged multiple student visits to PCRET facilities to provide them with a first-hand look at the solar PV manufacturing process. In addition, four students completed internships with PCRET. USPCAS-E at UET Peshawar also has a joint research project with PCRET. As a result of the research collaboration, an auto-tracking system for solar PV systems was developed and commercialized. Both organizations are collaborating in the area of PV testing and training.

HEAVY ELECTRICAL COMPLEX

ASU supported its partners in developing a working relationship with Heavy Electrical Complex, the only high-voltage (HV) transformer manufacturing facility in Pakistan. Along with visits that provide students a first-hand look at the transformer manufacturing process, ASU supported the placement of two students as interns. USPCAS-E at UET Peshawar had two joint research projects with Heavy Electrical Complex that have commercialization potential. A transformer monitoring system that has been developed has been field-tested. Heavy Electrical Complex will be offering the product as part of its power transformer product, resulting in the commercialization of the product.

ISLAMABAD ELECTRIC SUPPLY COMPANY (IESCO):

IESCO is one of the most progressive utilities in Pakistan. ASU supported its partner USPCAS-E at NUST in developing a partnership with IESCO via a joint research project. Under the project, a fault localization system was developed and deployed and IESCO did the field testing of the product. The product is currently being updated based on the feedback from the product trials, and version two is in the works.

PESHAWAR ELECTRIC SUPPLY COMPANY (PESCO)

ASU supported its partner USPCAS-E at UET Peshawar in developing a partnership with PESCO. Recently, PESCO visited UET Peshawar's facilities as part of PESCO's grid operator training. USPCAS-E has developed a remote grid-monitoring unit for PESCO, which is being deployed. USPCAS-E also developed a remote transformer monitoring system as part of a joint research project with ASU. This system is currently being tested at PESCO grids. Once the testing is complete, the product will be commercially offered to electric utilities in Pakistan.

ENERGY DEPARTMENT OF KHYBER PAKHTUNKHWA

ASU supported USPCAS-E at UET Peshawar in developing a working relationship with the Energy Department of Khyber Pakhtunkhwa. UET Peshawar, with ASU's support, organized joint policy dialogues and a conference with the Energy Department. Also, with ASU support, UET Peshawar developed a 10-Year FATA Energy Plan and First Provisional Energy Policy. UET Peshawar has been declared as Khyber Pakhtunkhwa's Think Tank on Energy by the provincial government. It has supported the development of an Electrical Energy Policy for Khyber Pakhtunkhwa, which has been adopted by their Energy Department. The Government of Khyber Pakhtunkhwa is utilizing USPCAS-E's solar testing facilities for its solarization projects, resulting in revenue generation for the center.

MINISTRY OF CLIMATE CHANGE (MOCC)

ASU supported its partners in the development of a working relationship with the Ministry of Climate Change. As a result, USPCAS-E at NUST is emerging as an implementation partner on all matters regarding energy efficiency. USPCAS-E at UET Peshawar is working with MoCC on all issues regarding electric vehicles.

Alternate Energy Development Board (AEDB)

ASU has supported USPCAS-E at NUST in developing a partnership with AEDB. As a result, seven students from NUST were placed in project-based internships at AEDB. Students are working on the following at AEDB:

1. Alternative and Renewable Energy Policy
2. Off-Grid Electrification Policy
3. Floating Solar Policy
4. Hybrid Renewable Energy Policy
5. Net Metering Policy

UNITED NATIONAL INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO):

ASU supported its partners in developing partnerships with UNIDO. Now, both USPCAS-E at NUST and UET Peshawar are UNIDO's partners for implementing energy-efficiency projects in Punjab, Khyber Pakhtunkhwa and Baluchistan. As a result of these projects, USPCAS-E added energy auditing to its portfolio of services. Energy auditing is expected to be an ongoing revenue source for USPCAS-E.

GLOBAL CHANGE IMPACT STUDY CENTER (GCISC)

GCISC is a dedicated research institute for climate change studies in Pakistan. ASU has connected USPCAS-E at NUST with GCISC for joint research on climate change and energy. Three such research studies have already been produced.

PAKISTAN AERONAUTICAL COMPLEX (PAC)

ASU supported its partner USPCAS-E at UET Peshawar to become PAC's technical backstop partner. USPCAS-E is providing testing services and is working on technology development projects for PAC. USPCAS-E plans to establish a certified LabView Academy and will further enhance this partnership through the provision of skilled workers to PAC. Partnership with PAC has resulted in research funding for USPCAS-E in the area of condition monitoring, and both organizations are jointly pitching proposals for additional funding opportunities.





Asfandyar Khalid



**I never felt away
from home
because people
here are so loving
and accepting.**



Asfandyar 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."

"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 Asfandyar.

"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."

SECTION

5

THE CENTERS AT NUST AND UET PESHAWAR: PRESENT AND FUTURE



UNIVERSITY OF ENGINEERING AND TECHNOLOGY (UET) PESHAWAR

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

The United States invested \$15 million (USD) from 2014-2019 to establish the Center for Advanced Studies in Energy at UET Peshawar. In the heart of Peshawar, Khyber Pakhtunkhwa, a state-of-the-art building was constructed with all the facilities required for a modern institute of learning and innovation. It covers an area of 50,000 square feet and consists of interconnected but independent, administration and academic floors. There are five classrooms, eight state-of-the-art research laboratories, a conference room, a seminar hall, multiple office spaces,

separate common rooms for men and women, as well as rooms for faculty and postgraduate students. Special care has gone into ensuring that the needs of all students are adequately met, including students with disabilities. The building is equipped with ramps and elevator access to all four floors. The energy-efficient design makes full use of natural light, along with ensuring proper ventilation and use of space.

In the field of energy engineering, USPCAS-E introduced 106 new courses aligned with Pakistan's energy needs and global trends. In the area of developing a specialized energy workforce, 107 students and faculty, including 23 female students, visited Arizona State University for a one-semester program where they received training in applied research and entrepreneurship. USPCAS-E expects to graduate 266 students in different streams of energy engineering by the end of the 2019-2020 academic year.

During the project, USPCAS-E conducted 22 local applied and six joint energy research projects with ASU. It also organized national and international conferences on energy themes to inform and educate the public, policymakers, industry, government and academia about the importance of sustainable energy and also contributed to policy formulation for an energy sufficient Pakistan. The center raised more than \$1 million (USD) to support the activities post project closure.

Degree programs

M.Sc. Programs	Ph.D. Programs
Electrical Energy Systems Engineering	Electrical Energy Systems Engineering
Renewable Energy Engineering	Renewable Energy Engineering
Thermal System Engineering	
Energy Management and Sustainability	

Research labs	
1	Renewable Energy Labs
1.1	Material Synthesis Laboratory
1.2	Materials Characterization Laboratory
1.3	Solar Photovoltaic (PV) Efficiency Laboratory
2	Microscopy Laboratory
3	Electric Power Lab
4	Workshop Facility Laboratory
5	Simulation and IT Lab
6	Thermal Systems Laboratory

EXPECTED FUTURE ACTIVITIES

- 1 Continue to engage the private sector and energy institutions in applied research projects.
- 2 Develop joint research proposals with the provincial government, well-regarded international universities, and continue its relationship with ASU and OSU.
- 3 The Technology Center must become functional to take advantage of the training and technical support provided by ASU. It should seek accreditation from an international body to bring credibility to the testing and certification services.
- 4 Pursue a 3+1+1 degree program with Arizona State University; fund students for doctoral study at ASU.



NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY (NUST) ISLAMABAD

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

Realizing the need of energy education in the country, NUST established the Center for Energy Systems (CES) in 2012. At the time, CES offered only one master's program in Energy Systems Engineering. The objective of the creation of the center was to develop a pool of energy professionals in the country and to conduct and catalyze applied research to address the energy challenges of Pakistan.

NUST signed a cooperative agreement amounting USD \$15 million with USAID in 2014 and completed the project in September 2019 establishing a world-class Center for Advanced Studies in Energy.

Constructed on the main NUST H 11 Islamabad campus, the building is 60,000 square feet, with three executive offices, seven office cabins, 90 workstations, five lecture halls, eight energy research labs, a library, a seminar hall and a computer lab.

USPCAS-E currently offers 71 courses under three streams and six programs. The center has 24 faculty and a student enrollment of 636. NUST sent 110 exchange visitors to ASU. The center has graduated 217 students; it is expected this number will reach 243 by the end of 2019. The program awarded 305 merit and need-based USAID scholarships during the five-year project.

Degree programs

Stream	Programs	Status
Energy Systems Engineering	MS, Ph.D.	Currently offered
Thermal Energy Engineering	MS, Ph.D.	Currently offered
Electrical Engineering (Power)	MS, Ph.D.	Currently offered
Energy Policy and Management	MS	To be offered beginning fall 2020

Research labs

1	Energy Storage and Conservation Lab	6	Solar Energy Research Lab
2	Fossil Fuels Research Lab	7	Smart Grids and Electrical Power Systems Lab
3	Thermal Energy Research Lab	8	High-Performance Modeling/Simulation Lab
4	Biofuel Research Lab	9	IT Laboratory
5	Advanced Energy Materials and Systems Lab	10	Machine workshop

USPCAS-E awarded 15 local applied research grants and five joint research projects with ASU worth PKR 3 million each. The program also provided 17 student research grants, each worth PKR 500,000. The center raised USD \$1.2 million from public and private partnerships and established an endowment fund of PKR 21 million to continue sponsoring its qualified and needy scholars.

EXPECTED FUTURE ACTIVITIES

- 1 Make the Technology Center fully operational with accreditation from an international body to bring credibility to its testing and certification practices.
- 2 Continue its engagement with the public and private sector and energy institutions in applied research projects.
- 3 Develop joint research proposals with well-regarded international universities and continue its relationship with ASU. They must also continue to explore funding options nationally and internationally.
- 4 Implement the plan for online degree programs to facilitate more students and further improve center revenue.
- 5 Launch the new energy policy program in 2020
- 6 Pursue a 3+1+1 degree program with Arizona State University; fund students for doctoral study at ASU.



Amir Nangyal



I decided to be an engineer and find a solution to this problem.



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.

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.”

SECTION 6

CONCLUSION: LOOKING TO THE FUTURE

The USPCAS-E centers at NUST and UET Peshawar made considerable strides in creating industry-responsive curricula and research capacity, fundraising and engaging stakeholders. Ongoing success is dependent on the ability of each center to retain faculty; create additional sources of income; and market their programs to increase and sustain enrollment, especially among women and other underrepresented groups.

KEY PROJECT METRICS AND ACCOMPLISHMENTS

Two important goals remain unfulfilled at this date: 500 graduates and gender equity among the scholars with 50 percent female participation. The goals in each area were laudable: having such aspirational goals provide the motivation to do what has not been done before.

Below are the key project targets and the final numbers. Numbers highlighted in green exceed the goal while numbers highlighted in yellow fell short of the goal. Gray is a projected number. Note that some tracked metrics had no defined target.

Factoring in the remaining 2019-2020 academic year, we project more than 500 graduates. We achieved almost 25 percent female participation in the exchange scholars program. Female enrollment at the centers was 155 or about 15 percent of the total. Female graduates accounted for more than 17 percent of the total graduates.

Key project metrics	Project target	Final
Stakeholder meeting participation	120	379
Male	90	343
Female	30	36
Degree programs developed	6	13
NUST	3	6
UET	3	7

Key project metrics	Project target	Final
Courses offered	40	151
NUST	20	71
UET	20	80
Applied research projects	30	36
NUST	15	14
UET	15	22
Joint research projects	10	12
NUST	5	6
UET	5	6
Exchange scholars (initial goal 50, revised to 100 and then 200)	200	217
NUST (male)		79
UET (male)		85
NUST (female)		30
UET (female)		23
Female scholars (percentage)	50%	25%
Enrollment	500	1,098
NUST	250	636
UET	250	462
Graduates*	500	509
NUST	250	243
UET	250	266

Key project metrics	Project target	Final
Workshops	10	14
Virtual seminars		9
Pedagogy (AIM) Training participants		33
Male		30
Female		3
Scholarships	500	555
NUST	250	305
UET	250	250
Internships	100	121
NUST	50	71
UET	50	50
Industry visits		51
Government officials and other stakeholders participating in a workshop.	33	28

Key project metrics	Project target	Final
Labs established**	20	16
NUST	10	10
UET	10	6
Libraries established	2	2
NUST	1	1
UET	1	1
Public-private partnerships	10	21
NUST	5	15
UET	5	6
Fundraising (USD)	\$2,000,000	\$2,222,835
NUST	\$1,000,000	\$1,164,755
UET	\$1,000,000	\$1,058,080

*Includes projections for academic year 2019-2020

**Sixteen primary labs were established plus three sub-labs at UET Peshawar and two Technology Centers, one at NUST and one at UET Peshawar for a total of 21.

TARGETS EXCEEDED

Targets were exceeded in the following areas: Stakeholder Meeting Participation, Number of Degree Programs Developed, Number of Courses Developed, Joint and Applied Research Projects, Exchange Scholars, Workshops, Scholarships, Internships, Public-Private Partnerships and Fundraising.

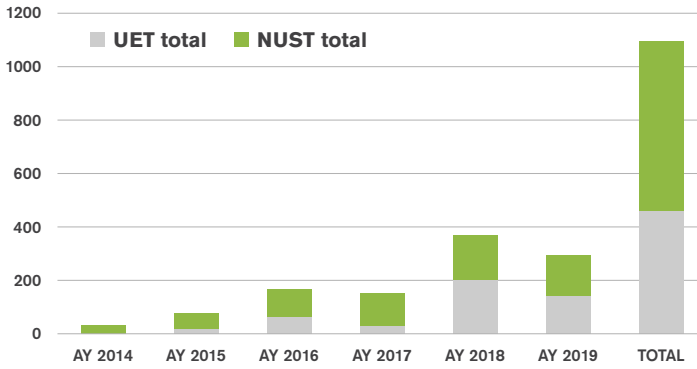
GRADUATION GOALS

The centers are close to achieving their graduation goals. In hindsight, we realize that the target set in the Cooperative Agreement didn't adequately account for the time required to get the programs up and running, especially at UET Peshawar. NUST had some programs in place to build on, whereas UET Peshawar did not. The center there had to build everything from the ground up. Hiring the necessary faculty was challenging for UET Peshawar as they had difficulty being competitive compared to other regions in Pakistan.

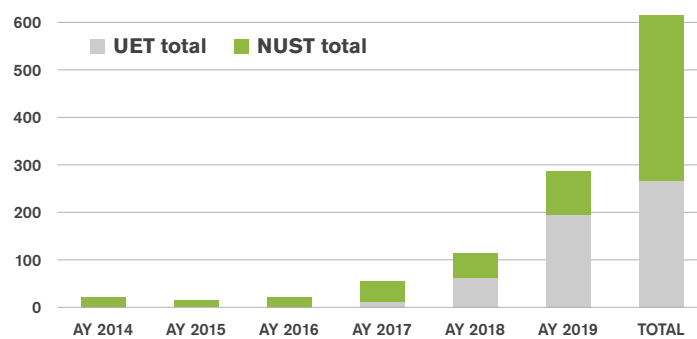
The exchange program was a transformational experience for the scholars. Unfortunately, it also added a semester to the time to degree for the students, and this also impacted the graduation goal. Compounding these challenges, continuous enrollment is not always the norm for graduate students in Pakistan. During the project, many students left for a semester or more and then returned, adding a semester or more to the time-to-degree.

The good news is that the number of students in the pipeline will allow the centers to realize and surpass the goal of 500 graduates in the current academic year.

▼ USPCAS-E Enrollment



▼ USPCAS-E Graduates



GENDER EQUITY

Similarly, the percentage of female students enrolled was also lower than hoped. It's important and necessary to set an ambitious goal for gender equity in engineering. Again, in hindsight, this enthusiasm should have been tempered with a survey of current enrollment trends in Pakistan and elsewhere. Using the United States for comparison, a goal of 20 percent for female enrollment would have been the standard in the U.S. and likely a stretch goal in Pakistan. A brief analysis of engineering enrollment in the U.S. is provided below for context.

COMPARISON OF ENROLLMENT FOR FEMALE STUDENTS IN ENERGY-RELATED DISCIPLINES IN THE UNITED STATES

The American Society of Engineering Education (ASEE) tracks enrollment data and publishes annual statistics for U.S. engineering programs. The data below are from the following report: asee.org/papers-and-publications/publications/college-profiles/

(Note that the majority of students in energy-focused studies in the United States are in either electrical or mechanical engineering programs.)

The overall ASEE female enrollment data at the bachelor's level for 2008-2016 (all disciplines):

Year	Female enrollment
2008	18.1%
2009	18.0%
2010	17.8%
2011	18.1%
2012	18.4%
2013	18.9%
2014	19.1%
2015	19.9%
2016	20.9%
2017	21.3%
2018	21.9%

The average yearly increase in female enrollment over this period was 0.38% —at the high end, the increase was one percent. If applied to the starting female enrollment for NUST and UET Peshawar, the overall enrollment predictions would have been much more modest.

Female students account for 56 percent of the total enrollment in higher education in the U.S. and have equal or better preparation. In spite of this, crossing the 20 percent threshold for female enrollment in engineering programs at the undergraduate level was a significant achievement at ASU. U.S. schools that have a higher percentage of female enrollment at the undergrad level are either highly selective or have long-standing programs geared toward the early recruitment of women in STEM fields.

ENROLLMENT IN THE U.S. FOR BS, MS, AND PH.D. PROGRAMS IN ENGINEERING

1. Enrollment in master's degree engineering programs in 2017 was 93,559 students.
2. In the bachelor's programs, the percentage of female students in electrical engineering was 14.2 percent, and in mechanical engineering, it was 14.8 percent. In 2018, the average enrollment of women in ALL engineering programs was 21.9 percent.
3. For additional context, the number of female tenured and tenure-track professors in engineering disciplines in fall 2018 was 17.4 percent overall, but only 14.3 percent in electrical engineering and 14.1 percent in mechanical engineering.

DEGREES AWARDED IN THE U.S. AT THE MASTER'S AND PH.D. LEVELS

In 2018, 26.7 percent of total master's degrees were earned by women. Of those, 23.5 percent were awarded in electrical engineering, 14.4 percent for mechanical engineering and 17.6 percent for petroleum engineering. ASU was ranked #4 in the country for this reporting year, and ASU's numbers were about the same as the national number.

At the doctoral level, degrees earned by women were 15.3 percent in mechanical engineering, 17.3 percent in electrical engineering, and 19.5 percent in petroleum.

BRINGING MORE WOMEN INTO ENGINEERING IN PAKISTAN

In addition to lower female enrollment in energy engineering disciplines overall, there were significant cultural barriers. UET Peshawar's location and cultural issues exacerbated this issue. At UET Peshawar, the overall female enrollment is four to six percent. The center increased female participation to 14 percent—a remarkable achievement—through various initiatives, including fully funded scholarships, the exchange program with ASU, and tuition fee waivers. The new graduate program in Energy Management and Sustainability also encouraged female participation. UET Peshawar needs to work proactively with its communications team and the Government of Khyber Pakhtunkhwa to promote the recruitment of female students to engineering programs. The potential is there, but women need active recruitment and demonstrated support and inclusivity, along with family support, to be successful.

Creating an inclusive environment and building on the success of female graduates can build a solid foundation for success in the area of gender equity. Again, marketing and outreach can help shift social norms to make engineering programs a common academic destination for Pakistani women, but this must be a longer-term strategy. The USPCAS-E project amassed many inspirational success stories about women and underrepresented students that could be used to market the programs going forward. Women in USPCAS-E graduated at higher rates, demonstrating that they can be successful.

Forming partnerships with HEC and industry to strengthen and improve secondary education for women and other underrepresented groups is key. Without this early preparation, engineering studies will remain out of reach for many of Pakistan's best and brightest.

INCREASING STUDENT SUPPORT SERVICES

At ASU, more emphasis on student support has resulted in better outcomes, including better graduation rates and job placement. Improving student support has been an ongoing effort at ASU and other universities in the United States. This might be an area for Pakistani universities to explore.

DATA ANALYSIS

Active enrollment management has transformed the student body at ASU. Part of this effort has been to use data collection and analysis tools to evaluate the market need for degree programs, competitive positioning, prospective student pools, time to degree, active recruitment and more. This might be a consideration for future higher education projects in Pakistan.

SUMMARY OF ACCOMPLISHMENTS FOR USPCAS-E AT NUST

ASU met most of its Cooperative Agreement targets for NUST; governance, curriculum, research, exchange and sustainability targets were all met.

1. ASU exceeded its curriculum target. Instead of creating three programs, six were developed and offered. NUST planned 20 new courses but developed 51 new and revised 20 existing courses with ASU's help.
2. The revised exchange target of 100 students and faculty was exceeded: 110 students and faculty completed the exchange program.
3. ASU completed six joint research projects instead of five.
4. ASU exceeded its sustainability targets for support in the areas of fundraising, internships, industrial contacts and stakeholder meetings.
5. ASU conducted 14 workshops and nine virtual seminars, going above and beyond its Cooperative Agreement commitments.

FUTURE NEEDS FOR USPCAS-E AT NUST

1. **Curriculum:** Continuing to partner with industry stakeholders would allow the center to introduce new courses and degree programs based on market needs. Continuous curriculum reviews and updates will ensure the curriculum meets national needs and follows international best practices.

In addition, NUST will offer the approved energy policy program in 2020.

2. **Research Labs:** Fully commissioning the procured lab equipment will benefit students and energy sector partners. Giving students increased access to laboratories will enable them to perform more and better research.
3. **Endowment Fund:** Building its endowment fund will enable the center to provide more scholarships to underserved populations.
4. **Research Projects:** Joint research projects with industry are a win-win for the center and its partners:

the projects will improve academia-industry relations, industry will benefit from the research, and the center will receive funding.

5. **International Linkages:** Working with ASU and other universities to develop a long-term relationship for student exchange and joint research would offer numerous benefits.

SUMMARY OF USPCAS-E AT UET PESHAWAR

ASU met most of its Cooperative Agreement targets for UET Peshawar. It is projected to reach its graduation goal in the 2019-2020 academic year.

1. ASU exceeded its curriculum target. Instead of creating three programs, seven were developed and offered. UET Peshawar was required to start 20 new courses but developed 80 new courses in energy engineering with ASU's technical support.
2. The revised exchange target of 100 students and faculty was exceeded: 108 students and faculty completed the exchange program.
3. ASU completed six joint research projects instead of five and supported UET Peshawar to complete 22 local research projects instead of 15.
4. ASU achieved its sustainability targets for support in the areas of fundraising, internships, industrial contacts and stakeholder meetings.
5. ASU conducted 14 workshops and nine virtual seminars, going above and beyond its Cooperative Agreement commitments.

FUTURE NEEDS FOR USPCAS-E AT UET PESHAWAR

1. **Ph.D. Program:** Ph.D. programs were not open for enrollment until the final year of the funded project. Now that they are established, Ph.D. student recruitment can commence.
2. **Industry Linkages:** USPCAS-E at UET Peshawar could work with the public and private energy sectors through its Office of Research Innovation and Commercialization to foster linkages and beneficial relationships. The center could position itself as the official consultant to the Government of Khyber Pakhtunkhwa for all energy-related consultancy and advisory work.

3. **Foreign University Linkages:** Developing linkages with international universities will be essential for UET Peshawar from a sustainability perspective and for improving the quality and status of its degree programs. Moving forward, the center will need to develop new linkages with international universities, and it has many leads to pursue.
4. **Patents and Startups:** The center could not effectively leverage its research efforts to file patents and commercialize products due to the short time allocated for research. A focus on developing patents, commercializing its products and developing startup companies would improve the center's chances to become sustainable by creating new revenue streams.
5. **Gender Targets:** Globally, enrollment in engineering among female students remains well below 50 percent. At UET Peshawar, the overall female enrollment is four to six percent. Still, the center was able to increase female participation to 14 percent through various initiatives like scholarships and tuition fee waivers. Additional focused efforts could further increase female enrollment.
6. **Technology Center:** The operationalization of the Technology Center is critical for the sustainability of the USPCAS-E at UET Peshawar and the enforcement of quality standards for solar panels in the province. The center could become the official body for the certification of all solar panels coming into Khyber Pakhtunkhwa.
7. **Hydro MS Degree:** Hydro energy resources are abundant in Khyber Pakhtunkhwa, but the province lacks the capacity to capitalize on this abundant natural resource. To develop a skilled workforce in this area, ASU proposed a master's degree program in Hydro Energy. Courses for the degree programs have already been designed with technical support from ASU and OSU and approved by the university board, but HEC approval is still needed. The next step is for UET Peshawar to work with HEC on the final approvals for the new degree.

CONCLUSION

As we wrap up this project, compile the data and reconcile our work against the Cooperative Agreement, it's clear that the long-lasting impact of USPCAS-E will be realized through the work of our scholars. Their journey is just beginning. Many of them spoke of being transformed by their USPCAS-E experience. They are making their mark in the world with a sense of purpose about their futures and with high hopes for Pakistan. We can't wait to see where they lead us.

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.

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Wajahat Ali

Administrative Assistant,
UET Peshawar

Arsal Latif

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Executive Administrative
Specialist

Ahmad Saeed

Deputy Director,
NUST

Ahmed Sohail Khan

Technical Advisor

Andrew Sarracino

Program Manager

Jake Kupiec

Communications Director

Ammar Yasser

Corporate Engagement
Specialist





Afshan Qamar



The big thing for me is the experience I got at the Photovoltaic Reliability Lab at ASU.



Participating in the USPCAS-E program put Afshan Qamar at opportunity's door.

"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."

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 Photovoltaic Reliability Lab at ASU," she says.

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.

Annexes: table of contents

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- 9 Fundraising report
- 10 Recommendations for future projects
- 11 Financial report

1. New programs and courses at NUST

Program/degree title	Type	Status
Electrical Energy Engineering	MS	Offered and Ongoing
Energy Systems Engineering (ESE)	MS	Offered and Ongoing
Thermal Energy Engineering (TEE)	MS	Offered and Ongoing
Energy Systems Engineering (ESE)	PhD	Offered and Ongoing
Thermal Energy Engineering (TEE)	PhD	Offered and Ongoing
Electrical Energy Engineering	PhD	Offered and Ongoing
MS in Energy Policy and Management	MS	Developed and will be offered fall 2019

Power System Operation, Control and Optimization
 Clean Energy Generation, Integration and Storage
 Advanced Power System Stability and Transient Studies
 Smart Grid Architecture
 Electric Power Quality
 Advanced Power System Protection
 Clean Coal Technologies
 Computer Modelling of Electrical Power Systems
 Electric Power Generation Transmission and Distribution
 Signal Processing for Modern Power Systems
 Biofuel Engineering
 Advanced Power Electronics
 Photobioreactor Engineering & Bio-Processing
 Photovoltaic Devices
 Applied Solar Energy
 Modelling of Energy Systems
 Solar Energy
 Energy Management in Buildings
 Energy Economics and Policy
 Fuel Cells
 Thin Films
 Development and Evaluation of Energy Projects

Wind Energy
 Power Distribution Systems
 Environment Impact Assessment
 Energy and Environment
 Energy Resources and Technologies
 Geothermal Energy
 Thermal Hydraulics
 Nuclear Energy Engineering
 Industrial Catalysis for Energy Systems
 Energy from Biomass: Thermochemical Process
 Energy Storage systems
 Functional nanomaterials for renewable energy
 Next-generation photovoltaics
 Energy policy analysis and planning
 Energy and Climate Change
 Industrial Energy management
 Sustainable Buildings
 Recent Trends in Energy Systems Engineering
 Socio-Economic Aspects of Energy Systems
 Contemporary Materials for Advanced Energy
 Advanced Converter Control Techniques
 Advanced Energy Materials: Synthesis & Characterization

Advanced Heat and Mass Transfer
CO₂ Capture, Utilization and Sequestration
Advanced Thermodynamics
Design and Modeling of Thermal Energy Systems
Conventional and Renewable Energy Power Plants
Advanced Fluid Dynamics
Turbomachinery
Environmental Issues of Fossil Fuel Power Plants
Advanced Heat and Mass Transfer
Fuels and Combustion
Computational Fluid Dynamics for Thermal Energy Systems
Process Intensification
Advanced Thermal Energy Storage Systems
Gas Turbine Performance
Solar Thermal Power Systems
Emerging Trends in Thermal Technologies
Sustainability in Thermal Energy Systems

Phase Change Thermal Processes
Laser Diagnostics for Thermal Engineering Applications
Advanced Combustion Kinetics
Technologies for Enhanced Heat Transfer
Advance Turbo-machinery Application
Analytical and Numerical Techniques in Heat Transfer
Biomass/Coal Gasification
Photocatalysis-Advancement and Applications
Nuclear Thermal Hydraulics
Smart Power Systems
Carbon Capture and Utilization
Technologies for Smart Transmission Systems
Electric Power Markets
High Voltage Engineering
Advanced Process Energy Analysis and Optimization
Advanced Heating, Ventilation and Air-Conditioning Systems



1. New programs and courses UET Peshawar

Program/degree title	Type	Status
Material for Energy Storage and Conversion (MESOC)	MS	Discontinued
Electrical Energy Systems Engineering (ESEE)	MS	Ongoing
Thermal Energy Engineering (TEE)	MS	Ongoing
Renewable Energy Engineering (REE)	MS	Ongoing
Energy Management and Sustainability (EMS)	MS	Ongoing
Electrical Energy Systems Engineering (ESEE)	PhD	2 students enrolled, however, USPCAS-E UET has revised graduation and scholarship targets and it only counts MS now
Renewable Energy Engineering (REE)	PhD	2 students enrolled, however, USPCAS-E UET has revised graduation and scholarship targets and it only counts MS now

Advanced Thermodynamics
 Thermal Power Plants Design and Operation
 Fuels and Combustion
 Energy Engineering Economics and Policy
 Advanced Fluid Dynamics
 Clean Coal Technologies
 Computational Fluid Dynamics
 Fuel Cell and Hydrogen Technology
 Rotodynamic machinery
 Advance Heat Transfer
 Advanced topics in Thermal Energy
 Thermal Desalination Systems
 Solar Thermal Energy
 Biomass Technologies
 Geothermal Engineering
 Environment Impact assessment for Energy Systems

Renewable Energy Technologies
 National/Provincial Energy Policies,
 Supply/Demand & Planning
 Management of Technology & Innovation
 Power Electronics and Machines
 CFD for Renewable Energy
 Wind Energy Engineering
 Solar Thermal Energy
 Hydro Power Engineering
 Biomass Technologies
 Geothermal Engineering
 Applied Photovoltaics Engineering
 Renewable Energy Mega Power plants
 Advanced topics in Renewable Energy
 Electrical and Optical Properties of Materials
 Materials Characterization Techniques

Advanced Topics in Energy Storage and Conversion
 Advanced Materials for Renewable Energy Systems
 Operation & Maintenance of Renewable Energy Systems
 Risk and Reliability Engineering
 Energy Quality management and Standards
 Energy Audit and Planning
 Environment Impact assessment for Energy Systems
 Development & Evaluation of Renewable Energy Projects
 Strategic Organization Management
 (Public/Private Sector)
 Sustainability Management
 Energy Quality management and Standards
 Management of Technology & Innovation for energy
 World Energy politics and supply chain analysis
 Energy Tariff and Financials risk management
 Energy Business Models and Marketing Strategies
 Global & Local Energy demand analysis
 Energy Service Companies Management
 Energy regulatory affairs & Business Laws
 Energy Project Management (Public & Private)
 Global sustainability & UN international obligations
 National/Provincial Energy Planning, Policies & practice.
 Environmental Impact assessment for Energy Systems.
 Energy Audit and Planning
 Energy security studies
 Energy modeling, Optimization and decision making
 Energy environment and climate change mitigation
 Transmission and Distribution
 Power System Operation and Planning
 Power System Stability
 Renewable Electrical Energy System
 Management of Technology and Innovation
 Advanced Power Electronics
 Distributed Generation
 Electrical Energy and Environmental Systems
 Advanced Topics in Electrical Energy System
 Power System Modeling and Analysis
 Analysis of Faulted Power System
 Power System Protection and Switchgear
 HVDC Transmission Systems
 HVAC Transmission Systems
 Overvoltages and Transients
 Power System Reliability
 Power System Control
 Electrical Insulation Engineering
 High Voltage Engineering and Design
 Power System Transformers
 Rotating Machines
 Electrical Power Generation
 Smart Grid
 Distribution and Utilization
 Power Quality
 Power System Substation
 Generation and Integration of Renewable Energy
 Computer Modeling of Electrical Power System
 Smart Grid Architecture
 Control of Voltage Source Converter for Grid and Drives
 Communication and Control in Electrical Power Systems
 Advanced Topics in Distributed Generation
 Advanced Topics in Smart Grids
 Advanced Topics in Power Electronics
 Automated Distributed Power Systems using data
 communication
 Advanced Topics in Renewable Energy Integration
 Advanced Topics in High Voltage
 Electrical Energy Market
 Engineering Economics and Management of Electrical Power
 System
 Material Sciences & Properties of Materials
 Electrochemistry
 Electrical & Optical Properties of Materials
 Materials Characterization Techniques
 Research Methodology
 Nanofabrication Techniques
 Advanced materials for energy applications
 Survey for Energy Technologies
 Thin Films
 Materials Thermodynamics

2. Trainings 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	Oct. 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	Aug.1 – 3, 2016
4 Harvey Bryan	ASU	Green Building Workshop: U.S. and Pakistani Practices	Dec. 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	Sept. 27 – 29, 2017
8 Alan Paul	Giant Angstrom	Strategic Proposal Development Workshop	Feb. 6 – 8, 2018
9 Zachary Holman	ASU	Energy Materials: Research Opportunities in Photovoltaics	Feb. 7 – 9, 2018
10 Lou Farina	Windmill Ridge Ventures	Corporate Engagement	April 19 – 20, 2018
11 Kendra Sharp	OSU	Hydropower	Sept. 24 – 26, 2018
12 Peter Rillero	ASU	AIM Training Workshop	Jan. 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	Nov. 2016
2 A.M. Kannan	ASU	Hydrogen Economy: Problems and Prospects	Feb. 2017
3 Brian Fronk	OSU	Introduction to High Temperature Solar Thermal Power Generation	May 2017
4 Zachary Holman	ASU	Where will solar go next?	Sept. 2017
5 Govindasamy Tamizhmani	ASU	Solar Photovoltaics - Testing and Certifications	Dec. 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	Sept. 2018
8 Ken Mulligan	ASU	Developing an Entrepreneurial Mindset	Dec. 2018
9 Kendra Sharp	OSU	Open-source Hydropower Assessment Tool (HPAT) Package	April 2019

3. Student internships

UET internships as of November 2019

Organization	Number of interns
WAPDA	6
KPOGCL	21
PESCO	17
PEDO	8
Total	52

NUST internships as of September 2019

Organization	Number of interns
Attock Gen Limited (AGL)	17
PCRET	10
Renewable Stars	4
Wapda	3
SKYElectric	2
SAARC Energy Center	2
Economia Pvt Ltd	4
National Internship Program (NIP)	8
Sailkot Grid Station	1
Renewable Electrical Technologies	1
MEPCO-Multan Electric power supply company	1
Step Robotics	2
Tefta Consultants	1
Heavy Electrical Complex	1
National Energy Efficiency & Conversation Authority	4
Planning Commission of Pakistan	10
Total	71

4. Industrial visits: NUST

NUST industrial visits			
Name of company/organization		Date	Program
1	Industrial visit to Noon Sugar Mills	Dec. 22, 2015	Energy Systems Engineering
2	Academic visit to NINVAST	May 19, 2016	Energy Systems Engineering
3	Industrial visit to Ageco Pvt Limited	Oct. 5, 2016	Energy Systems Engineering/ Thermal Energy Engineering
4	Industrial visit to Attock Generation Limited	Dec. 19, 2016	Electrical Energy Engineering
4	Bestway Cement Hattar Unit	Oct. 18, 2017	Thermal Energy Engineering
5	Pakistan Council of Renewable Energy Technology	Nov. 8, 2017	Energy Systems Engineering
6	High Voltage and Short Circuit Lab	Nov. 8, 2017	Faculty and Lab Engineers
7	High Voltage and Short Circuit Lab, Rawat	Dec. 15, 2017	Electrical Engineering (Power)
8	USPCASE Faculty Dr. Adeel Javed visited Golden Pumps Gujranwala. The purpose of visit was to collaborate in multiple areas in which USPCASE can advance the pump industry	Feb. 19, 2018	Thermal Energy Engineering
9	Industrial visit to Mirage Rebuild factory, Kamra	March 7, 2018	Thermal Energy Engineering
10	USPCAS-E faculty member Dr. Arsalan Khawaja, Mr. Saeed Iqbal and two research students visited PEL, Lahore	April 3, 2018	Electrical Engineering (Power)
11	Industrial visit to KSB Pumps, Hasanabdal	Oct. 11, 2018	Thermal Energy Engineering
12	Mangla Power Plant visit	Nov. 7, 2018	Electrical Engineering (Power)
13	Visit to PCRET	Dec. 5, 2018	Energy Systems Engineering
14	Dr. Hasaan and research students visit to biogas production Plant, Sargodha	Nov. 15, 2018	Faculty and research students
15	Dr. Adeel Javed, ILO and research students industrial visit to Mukhtiar Engineering Works	Sept. 4, 2018	Faculty and research students
16	Dr. Adeel Javed, Dr. Majid Ali and ILO visit to Saddique Leather Works	Dec. 6, 2018	Faculty

4. Industrial visits: UET Peshawar

Name of company/organization	
1	Next Generation Technologies (ICONGET, 2016)" at Ghulam Ishaque Khan (GIK) Institute of Engineering and Technology, Topi, Pakistan
2	Visit to Haier, Pakistan
3	LUMS and IT University Lahore
4	Industrial visit to PCRET Islamabad
5	Industrial visit to National Power Control Center-NPCC
6	Industrial visit Pakistan Ordinance Factory (POF) Sanjwal 5 MW PV Power Plant Sanjwal
7	Industrial visit to High Voltage and Short Circuit Laboratory - RAWAT, NTDC & 500 kV RAWAT Grid Station
8	Industrial visit to Hydrolink Taxila and 20MW Micro Hydro Turbine in Takhtbhai
9	Industrial Visit to Ghazi Barotha Dam
10	Meeting with Engr. Rashid Iqbal Answari, Ex-Faculty Member at E&ME College NUST
11	Meeting with Muhammad Ziauddin, CEO, Elan Partners (Pvt.) Ltd
12	Industrial visit to National Centre for Physics (NCP) Islamabad
13	Industrial visit to FECTO Cement Plant
14	Industrial visit to Hattar industrial estate Kot Najibullah Heavy Electric Complex
15	Industrial visit to Premier Sugar Mill
16	Industrial visit to Hydrolink Takhtbhai and 20MW Micro Hydro Turbine in Takhtbhai
17	Industrial visit to NTDC Rawat Grid Station
18	Industrial visit to Aviation Complex City Kamra
19	Visit to Parliament, Islamabad
20	PSO Karachi
21	Sanjwal Solar Power Plant
22	National Assembly of Pakistan
23	Siddiq leather works
24	Hydrolink Eng and Equipment Company ltd visit
25	Ghazi Barotha Power Plant
26	Neelum–Jhelum Hydropower Plant
27	Industrial Visit to High Voltage and Short Circuit Lab 500KV Rawar Grid
28	Industrial Visit to Attock Oil Refinery
29	Industrial Visit to Coronet Foods Hattar (EBM)
30	Visit to Tobacco Fields and Pakistan Tobacco Company Depot
31	CHASNUPP CENTER FOR NUCLEAR TRAINING (CHASCENT) VISIT
32	Industrial Visit to Kohat Textile Mills Ltd.
33	EMS faculty and students industrial visits to Micro Hydro Projects in Swat & Chitral
34	Industrial visit to Siddique Leather Works
35	Industrial Visit to Wah Noble Group of Companies Limited

5. Energy plan for Pakistan

NATIONAL ENERGY RESEARCH AGENDA

Significant human and financial investments have been made in Pakistan's energy research infrastructure. There is now an urgent need to align these resources strategically to address national needs. ASU took the lead in working with the energy research institutions of Pakistan to identify current strengths and capacities. The goal is to form a network of researchers that can work together to meet the country's energy research needs. A consultative session was organized by ASU in September 2019 to discuss the direction of future energy research. Researchers from nine centers in Pakistan attended the event.

Dr. Sayfe Kiaei provided a summary of the meeting objectives and explained why there is a need to formulate an energy research agenda for Pakistan. All participants introduced themselves and shared their center's research areas and activities. The group reviewed a draft energy research agenda prepared by ASU, and Dr. Ghulam Sarwar from the Higher Education Commission shared HEC research funding opportunities under their newly established governance structure. The presentation included details of HEC's Local Challenge Fund, Grand Challenge Fund, Technology Development Fund, National Research Program for Universities, and Technology Transfer Support Fund.



NEXT STEPS

- Centers are encouraged to pursue proposals in their respective domains through HEC's Grand Challenge Fund; the call for proposals will be announced between June and September 2020.
- Develop a new proposal to resolve the procurement issues affecting research work to replace the current Public Procurement Regulatory Authority rules for HEC funding.
- Review the draft energy research agenda prepared by ASU and provide written feedback, especially related to challenges that have not been addressed, such as energy policy.
- Develop a concept note on research ideas and titles for HEC's Grand Challenge Fund.
- Create a single platform that offers a hub of solution providers from industry, academia and government that can meet the energy research needs of Pakistan.
- Create a plan detailing ways to maximize Pakistan's:
 - hydropower potential.
 - existing power capacity and promoting efficient usage.
 - scientific expertise for policy formulation and implementation.
- Seek investment in agricultural energy technologies and renewables such as bioethanol energy.

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National Agenda on Energy Research FOR PAKISTAN



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Partnering Universities:



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

National Agenda on Energy Research

FOR PAKISTAN

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Purpose of the Document

Significant human and financial investment has been made in the development of the energy research infrastructure in Pakistan. Currently, research in this domain takes place in both academic and non-academic settings. Now, there is an urgent need to align these resources strategically to address national needs. This document has been developed at the request of the Higher Education Commission to serve as a guideline for developing the future research direction for energy research institutions in Pakistan.

Background

Under the leadership of the HEC, the number of universities has almost quadrupled from 52 accredited institutions in 2001 to over 190 accredited institutions today. Research output has increased from just under 800 publications in 2001 to more than 12,000 publications in 2015. Significant investments have been made in faculty development through international and indigenous scholarships and training programs. Now, more effort is required to support these newly trained scholars in applying their knowledge to research and innovation in Pakistan.

In its Vision 2025 statement, HEC sets forth an ambitious research agenda that positions higher education institutions as the principal drivers of a knowledge-based Pakistani economy. There is an urgent need for change as multinational institutions seek to fund applied research relevant to national needs. For example, the World Bank will be funding relevant and cutting-edge research in universities through its Higher Education Development in Pakistan Project. This includes support for multisector and multidimensional research on specific themes within sectors of national interest through provision of Grand Challenge Fund Grants to universities.

Upon the request of the Chairman of the Higher Education Commission, Arizona State University is working with the energy research institutions of Pakistan to identify current strengths and capacities. These collective strengths form a network of energy researchers, a hub of solution providers that can meet the energy research needs of Pakistan.

The following report is a summary of these discussions.

Grand Challenges in Pakistan's Energy Sector

Pakistan Vision 2025 establishes quantitative targets in the following areas:

- Provide uninterrupted and affordable electricity.
- Increase access to electricity.
- Reduce the average cost per unit by improving the generation mix and reducing distribution losses.
- Increase the percentage of indigenous sources of power generation and address demand management issues.
- Increase the use of energy-efficient appliances and products.

Building on the Vision 2025, the Ministry of Energy¹ is developing an Integrated Energy Plan for the next 28 years (2019-2047) based on four principles:

- **Sustainability** of production and use of energy
- **Affordability** of energy for all segments of society
- **Responsibility in the** use of energy, i.e., conservation and energy efficiency
- **Availability** for all, including those currently without access

As evident from the above, the issues of energy access, affordability, indigenization and rational use are being reiterated, irrespective of changes in governments, and hence provide a broad framework for the development of energy research agenda. Building on the discussions with energy research centers in Pakistan and related policy documents², these are Grand Challenges for the Energy Sector of Pakistan along with corresponding current research projects and their potential impacts:

Grand Challenge 1: Increase electricity access in Pakistan

Research Projects	<ul style="list-style-type: none">▪ Develop a technically stable and financially sustainable model of multi-resource microgrids in Pakistan (including solar, wind, biomass and micro-hydro).▪ Resolve the power quality issues of microgrids.
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¹ Based on interview and presentations of the Chairman, Prime Minister Task Force on Energy Reforms

² Following documents have been considered in development of the challenges: Draft Alternative & Renewable Energy Policy 2019, Draft Electric Vehicles Policy, NEPRA State of Industry Report, Ogra State of Industry Report, World Bank Report "In the Dark", Pakistan Energy Year Book, Friends of Democratic Pakistan's Integrated Energy Sector Recovery Report & Plan, TOR Prime Minister Task Force on Energy Reforms

	<ul style="list-style-type: none"> Assess the status of universal energy access in Pakistan per the World Bank’s multi-tier framework. Any other project addressing this grand challenge.
Impact	Between 25 and 50 million Pakistanis are living off-grid or end-of-grid. Finding viable and sustainable solutions and models for addressing the MEMs remains a pressing need. Under Pakistan’s commitment to Sustainable Development Goals, universal energy access is to be achieved by 2030. Research projects will contribute to the Government of Pakistan (GoP) target to increase electricity access from 67% to over 90% of the population by 2025.

Grand Challenge 2: Provide uninterrupted and affordable electricity while improving the generation mix and reducing distribution losses in Pakistan

Research Projects	<ul style="list-style-type: none"> Develop national targets for the fuel mix for the next 5, 10, 15, 20 and 25 years, with consideration of internal energy market trends, environmental factors, local fuel availabilities, and foreign exchange considerations. Develop an economic dispatch model for all power plants in the system, private and public, to achieve lower costs and optimal operations. Identify and facilitate the local development of advanced metering technologies for improved secondary and tertiary energy sector recoveries. Any other project addressing this grand challenge
Impact	The levelized cost of energy in Pakistan is not competitive compared to other countries in the region. Energy is key to production in a modern economy, so energy reliability and affordability are critical. Research projects will contribute to the GoP’s target to reduce the average cost per unit by over 25% by improving generation mix (15%) and reducing distribution losses (10%).

Grand Challenge 3: Increase the percentage of indigenous sources of power generation in Pakistan

Research Projects	<ul style="list-style-type: none"> Develop and update the renewable integration plan based on system studies.
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	<ul style="list-style-type: none"> ▪ Identify opportunities to maximize indigenous production of electric vehicle (EV) parts and develop a showcase (a pilot line) to reduce reliance on imported fuels. ▪ Identify indigenization opportunities within the value chain of solar PV and develop a pilot production line. ▪ Any other project addressing this grand challenge
Impact	<p>Currently, fuel imports are \$17B, almost 75% of the value of total exports. This is not sustainable. Renewable resource options provide the most viable alternative for Pakistan. Moreover, Pakistan's import power generation equipment is valued at more than \$1.5 billion a year, a market being served by foreign Original Equipment Manufacturers (OEMs) with minimal national contribution. Research projects will contribute to the GoP target to increase the percentage of indigenous sources of power generation to over 50% and the indigenous production of energy equipment.</p>

Grand Challenge 4: Increasing the use of energy-efficient appliances and products in Pakistan

Research Projects	<ul style="list-style-type: none"> ▪ Propose energy performance standards for different energy end uses, including appliances, based on local environments. ▪ Explore the feasibility of re-powering old public sector power plants. ▪ Develop a prototype or model for an improved appliances for Pakistan. ▪ Any other project addressing this grand challenge
Impact	<p>Although the total supply of energy to Pakistan's economy is 81 million tons of oil equivalent (TOE), the total energy consumption is 50 TOE. 40% of energy is lost in transformation, transportation, transmission and distribution, highlighting the need to incorporate energy efficiency in all sectors of the economy. Research projects will contribute to the GoP target to implement minimum energy performance standards for different sectors of the economy.</p>

Energy Research Centers in Pakistan

Academia plays a critical role in today's knowledge-based economy. To meet the current targets of the Government of Pakistan, academic institutions need to revamp their classical teaching-focused approach. Instead, colleges and universities should adopt a new model where they can play a vital role in evidence-based policy formulations and support the Government of Pakistan in embracing technology transfer. The following is a summary (in alphabetical order) of the expertise available within the country for energy research.³

Center for Energy Research and Development (CERAD), University of Engineering and Technology, Lahore

CERAD, established and operating since 2013 with support and funding from the Energy Department, Government of Punjab, bridges the gap between academia and industry and has developed expertise in technical services in the domain of renewable energy technologies, specifically solar energy.

Expertise	<ul style="list-style-type: none"> ▪ Graduate programs such as the MSc in energy engineering, vocational training in solar PV systems, pumping, UPS system and energy efficiency. ▪ Technical consultancy services, third-party validation services, PV and LED light testing and evaluation services, energy audit and energy conservation potentials, capacity building services. ▪ Renewable energy technologies such as PV pumping, EV, wind energy, biofuel, energy conservation, and the Advanced Coal Research Lab. ▪ PV testing, lab performing qualification testing according to IEC standards for performance assessment. ▪ The LED testing lab conducts performance assessments of indoor/outdoor LED luminaire as per specifications set by PEECA.
Major Collaborations	Energy Department Punjab, Punjab Energy Efficiency and Conservation Agency, FATA Secretariat, Higher Education Commission, Punjab Skill Development Fund
Alignment with Grand Challenges	Grand Challenges 3 & 4

³ This list is limited to Research Centers primarily focusing on Energy within Academic Setting. It is understood that Energy Research in Pakistan is not exclusive to them.

Energy Institute, Lahore University of Management Science, Lahore

Established in 2018, the Energy Institute at LUMS serves as a think tank, center of technical excellence, knowledge network, and capacity building resource for the nation. The mission of the LUMS Energy Institute is to carry out interdisciplinary research, development and capacity building in power and energy planning, renewable energy technologies and grid modernization.

Expertise	<ul style="list-style-type: none"> ▪ Interdisciplinary research, development and capacity building in power and energy planning, renewable energy technologies, and grid modernization. ▪ Smart grids. ▪ Energy informatics and evidence-based policymaking. ▪ Energy economics. ▪ Energy entrepreneurship and policymaking. ▪ Power electronics application in the energy sector.
Major Collaborations	Central Power Purchasing Agency, Power Information Technology Company, Ministry Climate Change, Ministry of Industries and Production, Punjab Energy Efficiency Conservation Agency, Hadron Solar, MTI, SOZO and Engineers Guild
Alignment with Grand Challenges	Grand Challenges 2, 3, 4

Energy Research Center, COMSATS University, Lahore

COMSATS launched the Energy Research Centre (ERC) in 2014 to act as a basic and applied research center committed to developing local resources, technologies and policy recommendations that lead to accessible, economical energy for Pakistan. The Centre has been tasked with guiding the process of developing and implementing the COMSATS research agenda across various disciplines, including electrical engineering, chemical engineering, physics, management sciences and economics at all campuses.

Expertise	<ul style="list-style-type: none"> ▪ Interdisciplinary research. ▪ Graphene material characterization facilities. ▪ Energy audits. ▪ Development of energy-efficient technologies. ▪ Microgrid/smart grids development.
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	<ul style="list-style-type: none"> ▪ Thermochemical gasification, biochemical gasification, biomass ▪ PV materials research platform. ▪ Battery test bench. ▪ Computational Fluid Dynamics (CFD) based simulation and modeling research platform.
Major Collaborations	Pakistan Science Foundation, National Science Foundation China, Guangzhou Institute of Energy Conversion (GIEC) China, HEC
Alignment with Grand Challenges	Grand Challenges 3, 4

Punjab Bioenergy Institute, University of Agriculture, Faisalabad

Established in 2014, Punjab Bioenergy Institute (PBI) at UAF was inspired by the Punjab Government’s goals to achieve self-reliance and sustainability in alternative energy resources. International research collaborations have been established with more technologically advanced countries for technology transfer and development. PBI is focused on providing domestic and industrial energy solutions. In addition, expert opinion and consultancy services for biomass waste-to-energy is also available to energy sector partners in Pakistan.

Expertise	<ul style="list-style-type: none"> ▪ Undergraduate program in Energy System Engineering (ESE). ▪ Biogas production and management. ▪ Insect biofuel production. ▪ Bioenergy cropping and residue management. ▪ Heat and mass transfer. ▪ Microbiology Laboratory. ▪ Bio-analytical chemistry. ▪ Biotechnology. ▪ Energy physics. ▪ Anaerobic digestion of wastes for fuel production. ▪ Biomass gasification. ▪ Energy crop cultivation and production on marginal lands. ▪ Energy materials, including solar cells, organic solar cells, and graphene.
Major Collaborations	Government of Punjab, Punjab Agriculture Research Board, Pakistan Science Foundation, HEC, Comstech, Pakistan Energy Research Council, UNESCO, Pakistan-U.S. Science and Technology Cooperation Program.

Alignment with Grand Challenges	Grand Challenge 3
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U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E), National University of Sciences and Technology, Islamabad

The Center for Energy Systems at NUST was established in September 2012 with a vision to be a world-class education and applied research center dedicated to resolving Pakistan’s energy crises and leading sustainable development through enterprise activities. Under a subsequent cooperative agreement with the United States Agency for International Development (USAID) in 2014, it was renamed the U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E). Advanced research and technology thrusts at the center include solar energy applications (PV and thermal); biofuel engineering, advanced energy materials and processes; thermal energy and fossil fuel engineering; smart grids and electrical power systems; energy storage and conversion; modeling and simulation; wind energy; and fuel cells.

Expertise	<ul style="list-style-type: none"> ▪ Graduate programs including Energy System Engineering, Thermal Energy Engineering and Electrical Power Engineering. ▪ Solar energy applications (PV and thermal) including synthesis, testing and training. ▪ Biofuel engineering process design and prototyping, ▪ Advanced energy materials and processes. ▪ Thermal energy and fossil fuel engineering, process design and prototyping. ▪ Smart grids and electrical power systems. ▪ Energy storage and conversion. ▪ Energy modeling and simulation. ▪ Wind energy. ▪ Fuel cells. ▪ Energy efficiency and conservation.
Major Collaborations	USAID, HEC, UNIDO, World Bank Group, Pakistan Science Foundation, Ministry of Planning & Development (Energy Wing)
Alignment with Grand Challenges	Grand Challenges 1, 2, 3

U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E), University of Engineering and Technology, Peshawar

Established with funding from USAID in 2014, the main goals of USPCAS-E UET Peshawar are capacity building and providing innovative solutions to address the chronic energy problems in Pakistan through applied research and graduates who are well prepared to meet the needs of industry stakeholders. USPCAS-E UET Peshawar has specialized human resources, technical facilities and applied research in electrical energy systems engineering (power engineering), renewable energy engineering, thermal systems engineering and energy management, policy and sustainability.

Expertise	<ul style="list-style-type: none"> ▪ Graduate programs in Electrical Energy Systems Engineering (Power Engineering), Renewable Energy Engineering, Thermal Systems Engineering, Energy Management, Policy and Sustainability. ▪ Policy dialogue and provincial think tank on energy. ▪ Electrical power system design. ▪ Solar PV energy applications including synthesis, testing and training. ▪ Advanced energy materials and processes. ▪ Power plant engineering. ▪ Thermal engineering process design and prototyping. ▪ Energy modeling/simulation. ▪ Fuel cells. ▪ Energy efficiency and conservation. ▪ Asset monitoring. ▪ Power electronics application in the energy sector.
Major Collaborations	Energy & Power Department KP, Higher Education Department KP, Department of Science & Technology KP, USAID, HEC, UNIDO, Heavy Electrical Complex, Avionics and Design Institute Kamra, UNFCCC
Alignment with Grand Challenges	Grand Challenges 1, 3, 4

Next Steps

ASU reached out to the energy research centers referenced in the document and held discussions to draft a broad framework for this energy research agenda. A questionnaire was developed to solicit detailed feedback from all energy research centers. Based on a review of the policy documents referenced in this document along with input received from the energy centers and in-house discussions, a list of Energy Grand Challenges for research in Pakistan was developed. This is a living document. After consultation from all stakeholders, it will be finalized.

These are the next steps toward finalizing this National Agenda on Energy Research:

Step 1:	Brief HEC on the work done so far on the development of a research agenda.
Step 2:	Conduct focus group sessions on the development of the draft research agenda for each thematic area covering key issues, identification of priority projects, data and information needs, capacity and technological needs, planning and implementation partners, and finances required.
Step 3:	Bring relevant ministries on board for the process, e.g., Ministry of Energy, Ministry of Planning and Development and others as needed. Consult with line ministries to develop the broad thematic areas of agenda.
Step 4:	Finalize the research agenda in a final national-level consultative workshop that includes energy experts and stakeholder organizations.
Step 5:	Launch the agenda at the USPCAS-E 6 th National Stakeholder Meeting with formal endorsements from Ministry of Energy and Higher Education Commission.

6. Self-assessment study report

ASU SELF-ASSESSMENT STUDY: MEASURING STAKEHOLDERS SATISFACTION UNDER ALL COMPONENTS

In addition to regular monitoring and data-tracking activities, ASU also designed and carried out a study with the assistance of an external consultant. The main objective of this study was to assess the success of the project in achieving the desired results and to gauge the satisfaction of the project stakeholders.

Support by ASU to the two centers was provided in five key component areas: governance, curriculum development and reform, exchange and scholarship programs, research, and sustainability of the centers. The study evaluated the project on five parameters: relevance, timeliness, quality, efficiency and the sustainability of the interventions. The study used all types of stakeholder observations to analyze the quality of work done by ASU.





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

Assessing support extended from Arizona State University (ASU) to U.S.-Pakistan Center for Advanced Studies in Energy (USPCAS-E) stakeholders

FINAL REPORT



Prepared by: Jawad Ali, PhD; Arjumand Nizami, PhD

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This report has been produced for review by the United States Agency for International Development (USAID). It has been prepared by Jawad Ali, PhD and Arjumand Nizami, PhD for Arizona State University. The authors' views expressed in this document do not necessarily reflect the views of USAID or the United States Government.

ACRONYMS

AEDB	Alternate Energy Development Board
ASU	Arizona State University
CAS	Center for Advanced Studies
ESE	Energy Systems Engineering
GoP	Government of Pakistan
HEC / D	Higher Education Commission of Pakistan / Department in KHYBER PAKHTUNKHWA
JRP	Joint Research Project
LEED	Leadership in Energy and Environmental Design
LoP	Life of Project
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
NEECA	National Energy Efficiency and Conservation Authority
NUST	National University of Sciences and Technology
OSU	Oregon State University
PC-1	Project Cycle – 1 Form
PI	Principal Investigator
PPP	Public Private Partnership
PMU	Project Management Unit
ToRs	Terms of Reference
UET	University of Engineering and Technology - Peshawar
USAID	United States Agency for International Development
USPCAS-E	U.S.-Pakistan Centers for Advanced Studies in Energy

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EXECUTIVE SUMMARY

This study was commissioned by Arizona State University (ASU) to assess ASU's support provided to newly established Centers for Advanced Studies in Energy at two Pakistani Universities – National University of Sciences and Technology Islamabad (NUST) and University of Engineering and Technology Peshawar (UET). The Centers were designed by the Higher Education Commission of Pakistan (HEC) and United States Agency for International Development (USAID) to support Pakistan's economic development by strengthening the capacity of Pakistani universities to respond to changing public and private sector needs for applied research and skilled graduates in the energy sector. The project is funded by the United States Agency for International Development.

The main objective of this study was to assess success of the project in achieving desired results and satisfaction of the stakeholders. The support by ASU to the two Centers was provided in five key areas - Governance, Curriculum Development and Reform, Exchange and Scholarship programs, Research, and Sustainability of the Centers. The study ascertained success of the project on five parameters - relevance, timeliness, quality, efficiency and sustainability of the interventions. The multiple stakeholders involved by the project have been presented on a matrix for interest and influence. The study has taken all types of stakeholders' observations for analyzing the quality of work undertaken by ASU.

In total 51 stakeholders were interviewed including 24 students through Focus Group Discussions, Key Informant Interviews and brief workshops.

The results of this study indicate that the support provided by ASU in all five key areas was successful and highly effective. The relevance, timeliness, quality, efficiency and sustainability were measured on a scale of 1-5 (1 being lowest and 5 being highest). The aggregate results show that the rating for overall effectiveness of various parameters was rated **4 and higher than 4**. The overall satisfaction on adequacy of support in all the 5 components was assessed on a scale 1-3 (3 being highest). **78%** of the total 51 respondents interviewed rated their satisfaction at the highest level whereas **22%** rated for medium. Interestingly, both the Centers located at two different universities, 200 kilometers apart and in two different socio-political contexts rated the support at almost the same level indicating that ASU had shown significant flexibility to adjust its support to the needs of both the Centers.

The stakeholders also identified areas for improvement if similar projects are implemented in future. The study makes conclusion and recommendations taking this feedback into consideration.

1. INTRODUCTION

This study was commissioned by Arizona State University (ASU) to assess ASU's support provided to newly established Centers for Advanced Studies in Energy at two Pakistani Universities – National University of Sciences and Technology Islamabad (NUST) and University of Engineering and Technology Peshawar (UET). ASU support to these Centers were provided under a Cooperative Agreement between ASU and USAID - 'Cooperative Agreement No. AID-391-A-15-00001. The study ascertains whether this support has been helpful in achieving desired results to the satisfaction of the stakeholders involved.

The USPCAS-E is part of a larger project co-designed by USAID and the Higher Education Commission of Pakistan (HEC) known as the Centers for Advanced Studies (CAS). The purpose of this project is to support Pakistan's economic development by strengthening the capacity of Pakistani universities to respond to high priority sectors' needs by gaining excellence in applied research, producing skilled graduates and forge public-private partnerships and networks to bring forward-looking knowledge of academia, government, business community and sector specialists together. Under this project, 4 Centers were established at Mehran University of Engineering and Technology, Sind (Water), Agriculture University Faisalabad, Punjab (Food Security), National University of Sciences and Technology, Islamabad (Energy) and University of Engineering and Technology, Peshawar (Energy). To support the two energy Centers at NUST and UET, USAID has signed three independent agreements with ASU, NUST and UET. The total US\$ 48 million financial allocation by USAID to support the two Centers was distributed as follows:

- Arizona State University: USD 18.8 million¹
- National University of Sciences and Technology (NUST) Islamabad: USD 14.9 million²
- University of Engineering and Technology (UET) Peshawar: USD 14.9 million³

The Cooperative Agreement of USAID for ASU support to USPCAS-E states the following:

- Deliver relevant and innovative research to meet the needs of clients (industry, civil society, government)
- Improve USPCAS-E curriculum relevance and quality, strengthen the use of effective teaching methods, and upgrade graduate degree and certificate programs and research facilities
- Strengthen engagement between USPCAS-E universities and stakeholders to support optimal linkages between supply and demand for USPCAS-E research, policy engagement and skilled graduates
- Increase access for talented, economically and/or culturally disadvantaged students, to high quality educational opportunities in the disciplines of food security/agriculture, energy and water
- Establish governance structures, fundraising and other elements of administrative capacity to support USPCAS-E sustainability at each university

¹ Page 3, Cooperative Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

² Page 26, Cooperative Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

³ Page 26, Cooperative Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

The USPCAS-E project success was hinged on leadership extended by HEC in furthering the need, objectives, and rationale for USPCAS-E as well as the institutional leadership emerging at each USPCAS-E university partners. The USAID expected that by the fifth year of program implementation, each Center will have established sustainable and productive partnerships with each other, their American partner university (ASU in this case), and diverse public-private stakeholders.

In summary, the support extended by ASU has aimed at multi-stakeholders including the community of NUST and UET, Higher Education Commission (HEC), private sector and the government.

The USPCAS-E at NUST and UET are producing skilled graduates as well as the applied research needed to advance the energy sector in Pakistan. Through this partnership, ASU is leveraging its expertise to help Pakistan harness its enormous potential in energy sector for economic growth through its universities. This assessment was cognizant of the contextual changes and it is reflected also in most of the interviews conducted with external stakeholders. Despite that CAS projects and ASU support were conceptualized in 2014 when some of these changes were yet to take place, the stakeholders analyzed effectiveness of USPCAS-E initiatives and ASU support with respect to the recent changes in the context (see chapter 3 for more detail).

This study evaluates desired result of the support provided by ASU under the Cooperative Agreement to support UET and NUST. The study objective was to assess ASU support provided to both partners universities under various components and other stakeholders as per agreed terms. Also, to what extent the support was helpful/useful in implementation of project activities, achieving desired results and, their satisfaction with this support.

1.1 METHODOLOGY

Four data collection methods were used in this study:

1. **Review of documents** provided by ASU and independently accessed by evaluation team.
2. **Bilateral / key informant interviews:** Such interviews were conducted with senior members of stakeholder institutions and the individuals in leading positions. Three different checklists⁴ for interviews were used for various stakeholders due to the type of group activities. These checklists were meant to provide a guideline for the interviews and were slightly tailored to the knowledge/expertise/position of the respondent by selecting questions relevant to the person/people being interviewed. It was not deemed necessary to ask every question to everyone.
3. **Focus group discussions / interviews:** Stakeholders with similar level of engagement and shared interests were interviewed through this tool (e.g. faculty, staff, students, exchange groups), while necessary faculty were also interviewed individually.

⁴ One each for the senior management staff, external stakeholders and students.

4. **Mini workshops:** This approach was useful for discussion with the students⁵. The two workshops (one each at UET and NUST, two hours each) helped exposing participants with provocative questions leading to understand quality and relevance of this support followed by plenary discussion on lessons learned.

The documents provided by ASU are listed in Annex 4; the checklists of questions taken up with the stakeholders are documented in Annex 5.

During the meeting with ASU staff, some of the additional observations, concerns and open questions were noted and kept in mind during the assessment:





1. How to **bridge the two distant actors**: Corporate sector demand where energy technology eventually lands, and academia (namely the two host universities).
2. **Gender integration** has been expected by ASU and USAID with *at least 50% female representation* in project activities (scholarships, exchange, enrolment etc.), which is ambitious.
3. What is the perceived **level of demand in the job market** for the students graduating from these centers with Masters' degrees in specialized fields?
4. Based on ground realities, there have been crucial instances where **adaptive planning** became imperative and ASU / Project Management Units (PMU) had to adjust their support towards partner universities. How flexible and yet suitable was this support, merits analysis.
5. **Defining sustainability** seems to be a challenge and dependent on several external factors – therefore assessment needs to focus on adequacy of ASU support only.

In total, 51 individuals were interviewed for this study. The respondents of the study were identified in close collaboration with ASU team in Pakistan. These included internal and external stakeholders (see Annex 3 – list of respondents consulted) to explore multiple questions, leading the evaluators to assess the overall satisfaction level towards ASU support.

1.2 UNDERSTANDING STAKEHOLDERS' MAP WITH RESPECT TO ASU SUPPORT

The USPCAS-E is founded on networking with a wide range of stakeholders. ASU shared their understanding of the stakeholders involved. **Internal stakeholders** include UET and NUST faculty and students. **External stakeholders** include HEC, industries, government officials, donors' community and others interested in energy sector. This analysis may be useful as a departure point for this study. It is important to see the stakeholders in perspective of their influence, interest and institutional position to ascertain where the support has impacted the most. A stakeholders' analysis was conducted separately for UET and NUST placing just a few selected stakeholders on the interest-influence matrix to capture an idea.

⁵The students interviewed came from Peshawar and Islamabad where the CASs were located and also from Swabi, South Waziristan, Shangla, Kashmir, Lakki Marwat, Sialkot, Quetta, Faisalabad, Rawalpindi, Jhelum and Lahore.

	High interest 	Low interest 
Influence High 	1 Vice Chancellor / Rector of the two universities Faculties and staff at both universities Principal USPCAS-E NUST PMU staff USPCAS-E UET (project-based actor) PMU staff USPCAS-E NUST (project-based actor) USAID	2
Influence Low 	3 Higher Education Commission Islamabad Higher Education Department KHYBER PAKHTUNKHWA Relevant faculties in USPCAS-E UET / NUST Students at USPCAS-E UET / NUST Industries in KHYBER PAKHTUNKHWA, Islamabad, Rawalpindi National Energy Efficiency & Conservation Authority Alternate Energy Development Board Peshawar Electric Supply Company (PESCO) KHYBER PAKHTUNKHWA Energy Development Organization (PEDO)	4 National independent energy experts Sub-national industrial ministries / chambers Pakistan Council of Renewable Energy Technologies (PCRET) Distant industries Other universities offering similar research services

1. Stakeholders (mostly internal) who offer their maximum time, interest and influence to ensure sustainability of ultimate desired outcomes of this project.
2. Stakeholders highly important to be engaged due to their high influence – USPCAS-E at both places need to acquire a level of excellence so that actors start seeing their direct stake in USPCAS-E sustainability.
3. Stakeholders who may have high interest and stake but are only indirectly consulted/ engaged. They do not directly influence USPCAS-E decisions. Their involvement is crucial and needs to be enhanced using innovative means and brought to the list of major players.
4. Stakeholders whose interest and influence are marginal in sustaining project results and investing in them is less relevant and may be taken up at a later stage.

Stakeholders may also be analyzed for thematic specializations being addressed by USPCAS-E (e.g. solar, hydro, wind or biomass energy, or with respect to policy, advocacy, governance, curriculum development etc.).

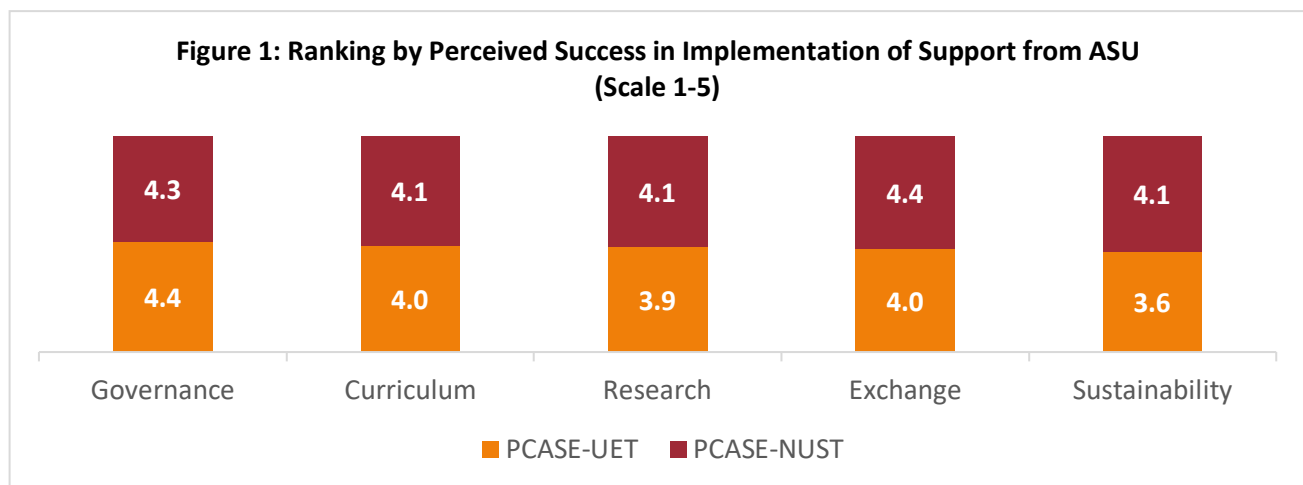
2. ASSESSING KEY SUPPORT AREAS – TARGETS AND ACHIEVEMENTS

This section covers all five areas of ASU support to USPCAS-E at UET and NUST. The respondents evaluated the question regarding overall judgment on ASU support based on latest progress reports. For analysis, the study team also benefited from additional information provided and observations made by ASU and Project Management Unit (PMU) teams at both the Centers.

- a) *Sound Governance, pertaining with the establishment of the Center*
- b) *Modernized and specialized curriculum development in energy*
- c) *Exchange and scholarship programs and new teaching strategies and methods*
- d) *Applied and Joint Research Projects, and*
- e) *Activities related to the long-term sustainability of the Centers*

All the stakeholders interviewed rated the extent of **targets achieved by ASU as “mostly achieved”** (see chapter 4) and exchange. In addition, **78% respondents from the two PMUs have recorded appreciation for ASU’s ability in adaptive planning and support** during the years. Annex 2 provides description of key parameters of the support expected to be provided by ASU and in how far these could be achieved.

On a 1-5 scale (1 lowest and 5 highest) the respondents assessed the overall success in achieving targets as very high (Figure 1). The most striking differences are in exchange and sustainability. The respondents at UET felt that exchange component could be made more successful by addressing certain issues such as timing of students’ exchange visits (after 3rd instead of 2nd semester) and making collaboration closer between students and faculty during exchange visits. In case of sustainability, NUST feels much ahead with its integration into NUST system. However, there are more steps to take in order to become sustainable such as industrial linkages. Some respondents feel that Center at UET can be sustainable if it is made a Center of Excellence governed by its own Board of Directors including members from the private sector, an on-going discussion between the university management and the government of Khyber Pakhtunkhwa. More details on sustainability and exchange in later chapters on relevance and effectiveness.



3. RELEVANCE OF ASU SUPPORT

3.1 HARNESSING COMPARATIVE ADVANTAGES OF USPCAS-E AT UET AND NUST

As per stakeholders' assessment, there are other elements which distinguish comparative advantages of USPCAS-E initiatives at NUST and UET analyzed in this section.

NUST based in Federal Capital Islamabad in a context where national discussions on energy sector are much dominant than specific sub-national issues. Hence federal level policies and institutional development are important for NUST to follow to remain more relevant. It is well placed to attract attention for policy engagement. The industrial climate in the capital city though evolving, is too small in scale when compared to other federating units of Pakistan⁶, yet NUST is benefited by its location attracting booming private sector in neighborhood industrial cities of Punjab (e.g. Rawalpindi, Gujranwala and Lahore).

UET is based at a public sector university located in Peshawar. Due to specific regional location is inclined to innovative, non-traditional energy sources such as bioenergy, solar power and micro-hydel power, but with an adapted scalability for medium and micro levels. The UET will need to consider the mountainous character of Khyber Pakhtunkhwa (60% geographical area), rich endowment of water resources in the high mountains, vulnerability to climate risks and extremes and relatively small/medium industrial activity (third largest industrial sector in the country)⁷, though growing fast along new Industrial Policy 2016.

In summary, the stakeholders opined that while NUST intends to specialize in broader energy generation and management research, UET's focus on renewable and alternative energy sources seems more favorable. The assessment shows that ASU has remained well cognizant of these differences and has tailored match-making efforts with the stakeholders accordingly. At federal level, beside industry, there is more connectivity with actors at the center of energy policy influencing narrative for Pakistan whereas in Peshawar a stronger focus is placed on connecting USPCAS-E with provincial players including government and industry.

3.2 REMAINING RELEVANT IN EVOLVING CONTEXT

The context within which USPCAS-E NUST and UET operate has evolved during the last five years heavily in favor of such specialized centers in Pakistani universities:

1. The political and security landscape of the country has recently witnessed positive signs of stability and recuperation in terms of attracting foreign investments. Therefore, the need for rapid industrialization has gained even more importance to uplift the country, especially in view of providing more jobs to youth.

⁶ https://en.wikipedia.org/wiki/List_of_Pakistani_provinces_by_gross_domestic_product. Accessed 16th February 2019

⁷ Ibid

2. The Industry has virtually remained hostage to energy crisis during the last two decades. The country's demand for energy is expected to rise at the rate of 10-12 percent annually in the foreseeable future. If this rate of increase continues, the demand for energy may well double before the end of 2019⁸.
3. Despite the above-mentioned stress, with improved geo-political situation, increased investment and other support factors, the industrial sector is growing by average 5%⁹ contributing average 21% to GDP and is a major source of tax revenues. A growing industrial sector is a contextual support for USPCAS-E in both places to thrive with their academic excellence and demand-based research offers.
4. The policy climate regarding energy and related sectors has evolved into much more favorable situation for the objectives of USPCAS-E.

The assessment observes that ASU support has harnessed favorable contextual change in favor of USPCAS-E sustainability at both universities. An increasing support from the host government has been harnessed for taking advantage of improved security and policy environment for UET. In case of NUST, linkages with federal institutions (such as NEECA, AEDB) help in remaining relevant to further influence the changing narrative in favor of non-conventional innovative sources of energy for Pakistan's development.

3.3 RELEVANCE TO GOVERNMENT POLICIES AND NEEDS

Pakistan is undergoing an unprecedented energy crisis. There is a demand and supply shortfall of 8000MW in the country (SDPI 2014). Pakistan has an installed electricity generation capacity of 33,836 MW in 2018¹⁰. Furnace oil (16%), hydel (27%), Natural gas (12%), LNG (26%), Coal (9%), Renewable (Solar & Wind 5%) and nuclear (5%) are the principal sources. During the next 10 years, peak electricity demand is expected to rise by 1,500 MW. Pakistan imports 400,000 barrels of petroleum products per day which costs approximately \$15 billion per year (Abbas 2015). Ever-increasing oil prices in the international market has burdened Pakistani economy. Promoting energy efficiency therefore has been the top agenda of the national governments for the last many years. Promotion of energy takes an important place in all recent major policy documents of Pakistan.

1. **National Power Policy 2013** stresses on energy conservation emphasizing on technology standards, power distribution and improving the energy efficiency in existing and new infrastructure. Due to the change in government, the material implementation of this policy began in 2014-15.
2. **Khyber Pakhtunkhwa Industrial Policy 2016** identifies unreliable energy supply as one of the leading challenges faced by industrialization, followed by lack of skilled employees and skills related training. This said, the policy places finding solutions to these challenges at a priority level. At another place, the policy pledges to improve environmental compliance by adopting green technology in multiple sectors.
3. **National Energy Efficiency & Conservation Act (NEECA) 2016** is all about promoting energy efficiency and source diversification in Pakistan. The Act resulted in establishment of an Authority (NEECA, re-designated from ENERCON) in Islamabad and provincial chapters.

⁸ <http://blog.pakistaneconomist.com/2018/02/08/industrial-development-pakistan-issues-challenges/>

⁹ <https://www.dawn.com/news/1335386>

¹⁰ <https://www.dawn.com/news/1454888/circular-debt-rises-to-rs755bn-pac-told>

4. **Draft National Industry Policy of Pakistan** to be announced in June 2019¹¹ recommends pragmatic shift in Pakistan's energy consumption pattern. It states that Pakistan's energy mix is skewed heavily towards more expensive sources of energy (64% thermal, 33% hydroelectricity). This policy will be a very important development in the context in which USPCAS-E are to strategize their research program.
5. **National Energy Policy 2013-18** states that Pakistan will develop the most efficient and consumer centric power generation, transmission, and distribution system that meets the needs of its population and boosts its economy in a sustainable and affordable manner (GoP 2013, 2).
6. **National Water Policy 2018** proposes hydropower development to increase the share of renewable energy (GoP 2018, 6). Sustainable water resources development has a close nexus with renewable energy is an important strategic priority of the policy.
7. **National Climate Change Policy 2012** devotes an entire chapter on Energy. The Policy further states that energy efficiency improvement, energy conservation and demand reduction provide excellent and cost-effective ways to ensure sufficient energy supply to achieve economic development goals, reduce carbon emissions and achieve climate change mitigation goals (GoP 2012, 24)

3.4 RELEVANCE TO NUST AND UET

Academia has been identified by all the above-mentioned policies as an important stakeholder, especially for conducting demand-based research and produce relevant competences for future leadership. The universities in Pakistan have so far taught disciplinary courses related to energy and technology. Interdisciplinary teaching on energy has been largely missing. Initiation of a masters' degree on energy therefore is a welcome move. This will open the doors for out of the box thinking on energy solutions in an energy deficient country. The objective of ASU support to developing MSc courses on energy within four streams, (i) Renewable Energy Engineering, (ii) Thermal Energy Engineering, (iii) Electrical Engineering, and, (iv) Energy Management and Policy, fits well within the broader objectives of the establishment of both the universities. The project fits well with the mandates of both the universities, NUST and UET i.e. teach and promote research on engineering and technology subjects. The mission statement of NUST includes to work on environment challenges, "develop NUST as a comprehensive, academic and research-led university with a focus on creativity, innovation and entrepreneurship so as to amicably negotiate social, economic and environmental challenges faced by the country". The UET has been teaching subjects related to energy for years.

3.5 OVERALL RATING BY INTERNAL AND EXTERNAL STAKEHOLDERS ON RELEVANCE

Both the internal and external stakeholders were asked to suggest if ASU support to UET and NUST was relevant for applied research, producing skilled graduates, for the industry needs and for the government priorities (Figure 2).

¹¹ <https://www.pakistantoday.com.pk/2011/04/20/national-industrial-policy-sets-ambitious-target-of-8pc/> accessed 15th February 2019

Figure 2: Relevance of ASU Support (Highest: 3, Medium: 2, Low: 1)

Perspective of Internal Stakeholders	Perspective of External Stakeholders
Demand for applied research in... 2.7	2.8
Producing skilled grads in Energy 2.6	2.2
Relevance to Industry Needs 2.1	2.6
Relevance to University 2.6	2.6
Relevance to Government... 2.7	2.4

As seen in the above graph, the distinguishing feature is the external stakeholders' tendency for rating relevance to industry needs at a higher level. This shows their interest and faith that such knowledge centers are much needed in the industrial and academic domains. Interestingly, although most of the external actors (e.g. industry) have a low influence on the management of USPCAS-E at both universities (see section 1.4 on stakeholders mapping), they see applied and joint research being conducted in the Centers benefiting them. The government stakeholder interviewed also rated relevance of ASU support high, as a contribution to improving energy situation in the country. The stakeholders however stressed the need to develop the Centers at par with such expectations and demand. The administration of both the universities must take cognizance of the challenges to be faced once USAID support including through ASU ends.

4. EFFECTIVENESS OF ASU SUPPORT

This section analyses effectiveness of ASU support provided to both partner universities with respect to the five components. While analyzing the effectiveness, the study takes account of the background in which the Centers were established so that effectiveness of ASU support is put in context.

4.1 STRENGTHENING GOVERNANCE

ASU has implemented the project in two well established universities with well-developed governing systems. ASU support was implemented in close collaboration with two other USAID-funded projects independently assigned to NUST and UET for establishment of USPCAS-E at each partner university. Therefore, the effectiveness of ASU support, particularly in governance and sustainability, may have greatly been influenced by these factors particularly the well-established governing practices of the two universities. Well-developed institution may sometimes resist change. USPCAS-E are emerging independent and flexible Centers within the overall governing frame of the university. If these Centers are not made independent, they will develop into usual departments of the universities. Therefore, decision-making regarding future governance of the Centers at

NUST and UET while the USAID-funded projects are still around for support, is crucial for these Centers to develop as originally envisaged by the HEC and USAID.

4.1.1 USPCAS-E AT UET PESHAWAR

The students at USPCAS-E UET come from remote areas in Khyber Pakhtunkhwa with humble backgrounds. They often lack opportunities to further increase their technical competences highly required in uplifting province and bringing it back to the progressive path. The USPCASE UET was established in 2015. It could not go off the ground till 2017 when ASU took over its operational responsibility as an adaptive planning measures and agreed arrangements with UET management that the USPCAS-E could operate as an independent entity outside University's regular systems reporting to the Vice Chancellor as a Project Director. The Center followed USAID procedures with required due diligence for its day to day operations including procurement and staff induction.

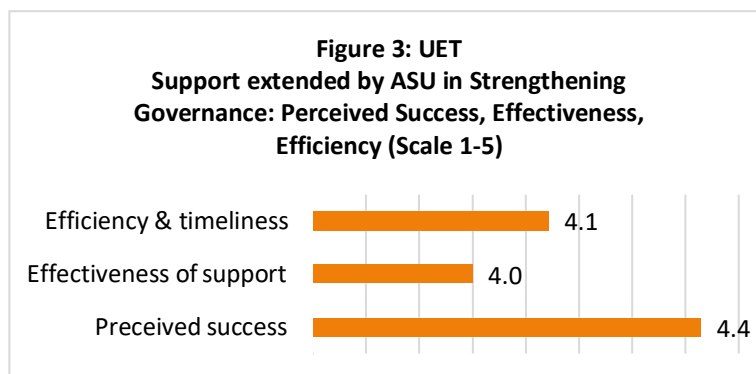
The USPCAS-E has been approved by the UET syndicate as a degree awarding institute of the university. 12 faculty members were recruited. The head of the Center (Deputy Director) is UET staff on leaves. The remaining PMU staff has been recruited from the market for the project duration. ASU assigned a Technical Advisor and a Deputy Director from ASU to jointly work with the Deputy Director of the Center.

The respondents rated overall success in achieving governance indicators and targets at 4.4 on a scale 1 to 5 (5 being highest, Figure 3). This support was rated as highly effective (4) and was delivered in an efficient manner (4.1). The respondents have rated these indicators while considering the fact, that the Center is not

yet there at acquiring fully independent governance that can function on its own without support from ASU – this discussion has been recorded in the section later in the report.

The respondents indicated the following main factors attributed to the effectiveness of ASU support for governance of USPCAS-E UET:

1. All necessary committees have been established and are functional. ASU regularly participates in the meetings and provides essential inputs for improved governance. The lead for these fora is with UET.
2. The Technical Advisor from ASU was physically present at the center and was readily accessible for day to day support and backstopping role towards PMU. The role of technical advisory is extremely effective as unanimously indicated by all PMU staff.
3. Corporate Engagement Officer at ASU has extended great support in making linkages between faculties / researchers and potential clients (such as corporates, public companies).
4. Although one of the challenges identified in the report is the need for improved visibility of both the centers at NUST and UET, the role of communication in branding and promoting the image through brochures, booklets, media, press, workshops and social media has been impressive.



5. UET and ASU work as a team in all respects to acquire effective governance for USPCAS-E. The examples include corporate engagement, liaising and networking, communication and M&E.
6. UET's core interest is to establish the Center as a think-tank and a hub for technology transfer and not just as a degree awarding place. PMU is reportedly promoting public private partnership (industry, academia, government). Within a short period of less than two years, several linkages were activated. A high level of ownership was conveyed from the offices of Additional Chief Secretary and Higher Education Department – crucial to acquire credibility as a recognized institution in the province.

The Cooperative Agreement sets high standards for gender integration in governance, management and outcome. The respondents shared that mainstreaming women in advanced studies in energy is expected at 50% which is considered far challenging, especially in the context of Khyber Pakhtunkhwa where tribal and difficult contextual history prevails. It was however impressive to note that UET is striving to take affirmative actions for improved gender equity. Examples, as reported by faculty members and students, include:

- Scholarships are granted based on academic excellence and for financial support to low income groups. In local context these would not match since students from humble and remote backgrounds may not compete on academic excellence with their counterparts from better families. Hence 5-7% adjustment is tolerated to mainstream such students including women. 60% scholarships are merit-based and 40% for humble backgrounds. A specific favor paid off. Out of 40% students, at least 70% were observed uplifted in their performance and demonstrated good value for money – especially women.
- For women to qualify for scholarships, maximum annual income of their guardian is higher (PKR.140000) when compared to PKR.70000 for the boys. This is to encourage more women in the scholarship bracket.
- The students (including female students during interviews) reported a highly women-friendly environment at UET. Working in gender-mixed groups is encouraged whereas the same may be considered culturally insensitive in other faculties within the UET and other universities.

4.1.2 USPCAS-E AT NUST

NUST founded the Center in 2012 whereas the RFP for USAID support was prepared during 2013-14. USPCAS-E is integrated in the NUST's regular system just like other schools established by NUST. Therefore HR, recruitments, procurements, etc. were conducted following NUST's manuals. Due to the integrated set up, USPCAS-E at NUST has its own principal whereas a PMU (just like one at UET) operates project functions lead by a Project Director with differentiated roles. 60 people have been employed by the project including 20 faculty members, 10-11 lab engineers, admin, and PMU staff. In this pretext, ASU support to strengthening governance entails relatively less intensive day to day issues and is mainly focused on institutional content.

ASU was expected to appoint a Technical Advisor at each Center. A Technical Advisor was assigned to USPCAS-E NUST who discontinued after a while. The post remained vacant for two years. The Project Director, ASU faculty and ASU Technical Advisor for UET provided support to NUST on need basis. ASU appointed a full-time Technical Advisor based at ASU in September 2017. NUST accepted a trade-off with a distant international support over regular day to day and face-to-face support. The Deputy Director at ASU and the Corporate Engagement Officer extend support into the matters that require a closer support. This is another example where the ASU has shown flexibility to address emerging needs of the Centers.

The successful achievement of this component was rated at a high level by all the respondents (4.3 on a scale 1-5, Figure 4). The efficiency of support is rated at 4.6 and effectiveness at 4.2. The rating for effectiveness is high, yet it was only influenced by NUST's own decision to have Technical Advisor placed at ASU and not in Pakistan which had its own limitations

reflecting on effectiveness of ASU support. Another reason is that the structural support in governance component (when compared to curriculum, exchange and research) was relatively less crucial when compared to UET since most of the issues were handled by NUST through integrating the Center in its system. Therefore, this rating may be read as how important this support was for NUST in the first place instead of qualitative judgement on the effectiveness of support.

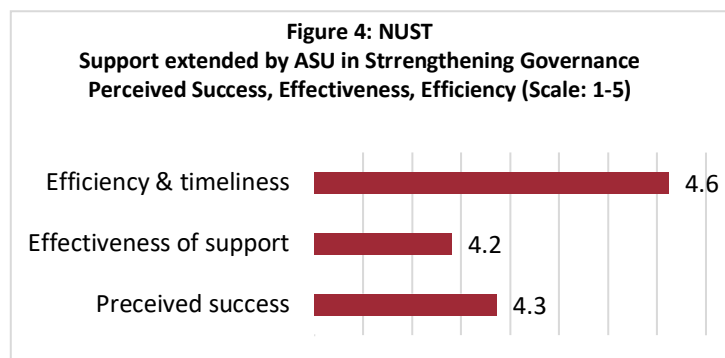
The success indicators in Governance component are described as follows:

1. All the structures are well-defined and working efficiently. ASU regularly attends the meetings for technical support. The lead for these fora is with NUST.
2. The Monitoring, Evaluation and Learning (MEL) members (ASU and PMU) work as a team to ensure synergies and avoid duplications.
3. 4 out of 20 faculty are women; exchange visits are also organized in a very gender-friendly manner giving full chance to female students.
4. The Technical Advisor's support is organized through Skype meetings and short-term missions to Pakistan. Urgent issues are tackled at ASU Pakistan. The support is appreciated by the respondent in general with a comment that a distant support has limitations as explained before.

It is evident that ASU has provided support beyond its original mandate. One example is the establishment of Technology Centers at both PCASE-NUST and PCASE-UET which were originally not included in the Cooperation Agreement. ASU realized that these are important for sustainability and supported. All the details pertaining to these technology centers are being handled by ASU – this also includes arranging funds through re-appropriation in relevant budget lines (UET only). A similar example is a special situation at UET where the Center needed an extra-ordinary support from ASU to ensure its continuation.

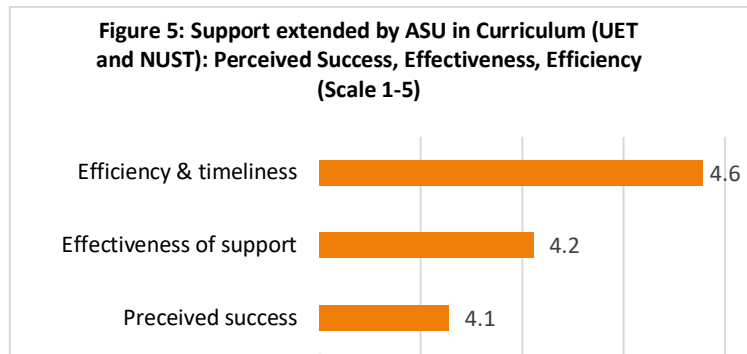
4.2 CURRICULUM REFORM

Most of the respondents stated that curriculum support from ASU surpassed targets. Under this component, curricula were revised, reviewed and monitored. Technically, the curriculum development processes were to be followed by the partner universities themselves and ASU task was to provide support in quality assurance and content review. However most of the meetings, approval processes, and lobbying were handled by ASU to assure fast delivery of curriculum content and courses' approval. Although not directly ASU's role, post-curriculum support was also pushed and pursued by ASU, such as faculty engagement to deliver these courses. The acquired number of courses is impressive. One degree program usually has about 20 courses. Hence a total achievement of 157 (51 NUST, 106 UET) is highly impressive.



Effectiveness of curriculum support was mostly rated at the highest level by the stakeholders (Figure 5). Curriculum support was rated at 4.1 (very high) in terms of overall success in accomplishment. It was rated highly effective (4.2), and it was delivered with high efficiency and timeliness (4.6).

The Technical Advisor for UET provided continuous resident support while the Technical Advisor for NUST provided remote support in addition to three visits for curriculum and holding conference sessions. HEC requires comparison among universities in Pakistan for similar courses and with similar universities around the world. Hence curricula must be same or at par with other universities for acquiring approval. Curricula review, and approval go through a long cumbersome process engaging relevant authorities. Once approved, it is hard to change content and pass through the same process. Therefore, timely feedback from ASU on curricula to improve quality was highly appreciated.



80% students interviewed have rated quality of curricula as better when compared to their previous degree institutions. They found curricula much more relevant to find practical solutions to the problems and less inclined towards theory. One of the stakeholders interviewed from private sector (Star Hydro) stated that he found quality of students at par with some of the renowned universities in Pakistan. Education delivered is highly productive, qualitative and practice oriented which needs to be maintained and improved. The respondent is a graduate from UET and got his master's degree from LUMS.

Students, faculty and external stakeholder at UET opined that curricula could be more tailored to Khyber Pakhtunkhwa's specific energy challenges¹² and potentials and therefore a stronger relevance for USPCAS-E UET existence in Peshawar. The respondents from AGES Consultants and China-Pak Three Gorges project pleaded the case for inclusion of micro-hydel engineering in degree courses. Other stakeholders also pleaded the same due to its micro and small hydro-power potential. AGES also offered support in formulation of courses on hydro-power. This could serve as a revenue stream since several donors are interested to invest and potential is high. This however never materialized for some reasons, perhaps, in respondent's view, due to pre-conceived thematic streams that could not be adapted to new ideas. The students also suggested that not all courses noted on the prospectus are being offered. They found faculty less mature when compared to previous departments where they studied their bachelors (often at the same university).

4.3 RESEARCH

Applied research, since the beginning, has remained on the mark and ASU support has remained exceptional and consistent throughout the period. Collaboration with corporate sector is at the heart of USPCAS-E existence in both partner universities. This agenda is supported through joint and applied research grants, an active

¹² High mountain remote areas scattered population, lack of access to fossil fuels, deteriorated biomass energy potential and lack of access to formal energy sources.

support for creating research-based linkages between UET and NUST and clients (public and private companies), conferences, workshops and seminars where potential clients also participate. Energy efficiency /conservation is a booming marketable field and much needed in Pakistan. However, the culture of R&D and innovation is not so prevalent in private sector. There is little demand for qualified engineers to find high quality solutions. USPCAS-E may change this, as stated by external stakeholders interviewed in this study.

4.3.1 JOINT RESEARCH

Joint research is a partnership between UET or NUST (with maximum budget of \$30,000) and ASU (with a maximum budget of \$40,000). Research topics are usually identified by Principal Investigators (PIs) in Pakistan and both PIs work together on a maximum time span of one year. Joint research proposals are submitted in response to call for proposals from ASU. At times it is hard to find a relevant PI at ASU for a joint research proposal. Joint research is an excellent opportunity for the partners to engage in a joint learning contract. The two PIs from partner universities and ASU work together with distant collaboration. ASU PI works from US whereas most of the work is performed on this side. Some PIs from ASU did not come to Pakistan specifically for the joint project discussions, although they have all visited Pakistan for other activities such as technical workshops. Also, PIs visit ASU at least once to discuss their projects with their counterparts at ASU.

4.3.2 APPLIED RESEARCH

Applied research is open for faculties in all the universities in Pakistan and is highly competitive (with a maximum grant of US\$30,000). In this case too, interested PIs send proposals in response to a call and may integrate students in the projects, also spanned over one year. Proposals are submitted to PMUs, evaluated, sent to ASU for comments, and approved or rejected. The process is reportedly very transparent and satisfactory. After the completion of selection process, ASU gives feedback to PIs for improving research proposals. Technical support from ASU in research includes helping and polishing research topics, research design, data analysis, publishing, sharing, equipping laboratories, and correctly using equipment. Final research reports are reviewed by PMU and ASU. Students may also benefit from internships opportunities with public and private companies. This proves important for opening job possibilities.

4.3.3 LABORATORY FACILITIES

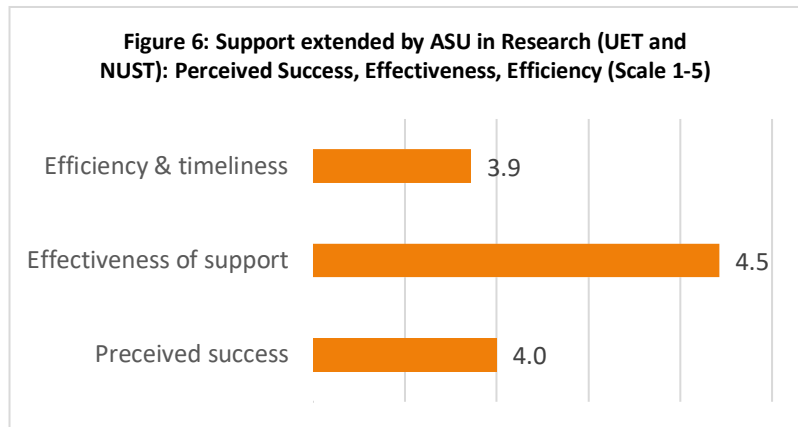
100% PMU and faculty members and 30% external stakeholders stated that these labs have achieved a level of excellence that these can generate resources for the USPCAS-E at both universities by offering demand-based commercial testing. UET indicated such demands already coming their way (e.g. iron testing, transformers repair, energy efficiency, etc.). NUST has not yet opened its facility for this purpose. In view of one of the external stakeholders, NUST needs to plan how access for private companies to these labs may be facilitated, without which labs' business plan is ought to fail. Most labs at UET and NUST have been equipped and are functional. Some final procurements are reportedly pending and will be completed within the remaining period. Faculty and students from UET noted that thermal lab was not ready yet and therefore students felt deprived of proper research opportunity. ASU is also supporting establishment of solar technology testing labs at UET and NUST which were originally not included in the Cooperative Agreement. Due to their importance for sustainability, budget re-appropriation was arranged to organize resources. Reportedly each lab has its own

business plan to recover its annual recurring costs through services. This may help in furthering research agenda since well-resourced and uninterrupted management of labs will ensure effective maintenance of equipment and the staff will improve their experience.

4.3.4 RATING OF RESEARCH BY STAKEHOLDERS

The stakeholders rated overall success of research at 4 (high), effectiveness at 4.5 (high) and timeliness of support at 3.9 (medium to high). This rating reflects that the respondents have been conservative with respect to their own success in research regarding timeliness (Figure 6).

They appreciate ASU's networking effort which helped enhancing applicability and relevance of research projects. PMU respondents at UET are concerned on continuation of joint research component in future. Some of them hoped for and looked forward to a continued collaboration with ASU. They thought that after five years of productive collaboration, there needs to be a proactive thought process on both



sides on how to continue in a post-project scenario for continuing this relationship¹³. In addition, ideas such as managing joint degree program, subsidizing exchange for students (albeit shorter duration) may also be discussed. The assessment also did not find any evidence of partner universities trying to forge a longer-term relationship and continuation with ASU.

4.3.5 NETWORKING AND LINKAGES

In general linkages between academia and industry are rare in Pakistan. To bridge this distance, a lot of networking and match-making support is extended from ASU in both applied and joint research and development. Research calls encourage PIs to knit linkages with corporate sector in the proposals; however, if they do not adequately do this, the USPCAS-E at both universities with support from ASU try to link and network with the relevant actors. 100% respondents rated effectiveness of support from ASU in joint and applied research at the highest level. Several examples were quoted of research collaboration, e.g.:

- National Transmission and Distribution Company (NTDC): Transmission dispatch and testing.
- Diamond Supreme Foam: Development and testing of insulation material.
- Builders in Lahore (Gulf constructors, Easy Deal): Insulation and energy efficient buildings (growing field).
- Coronet Foods Pvt. Ltd. EBM biscuit industry: Energy conservation from bakery for boilers.

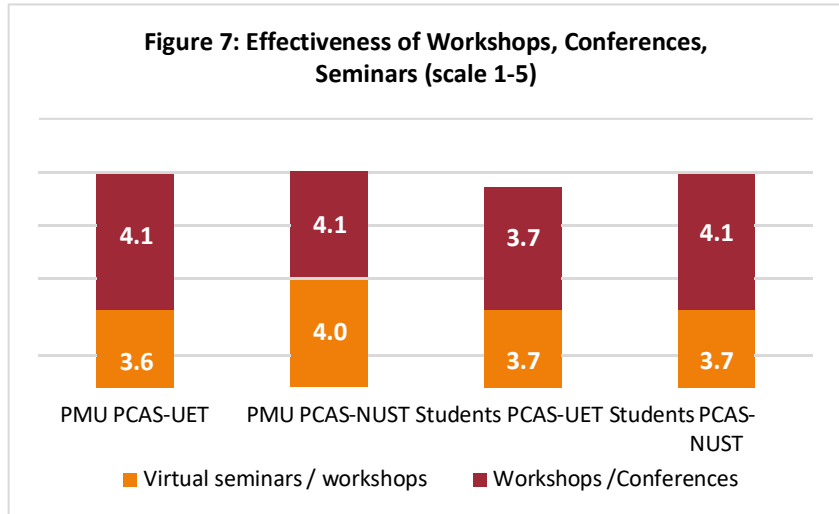
¹³ "Develop and implement a robust program of sustainable and long-term collaborative linkages between the Recipient (ASU) and its Pakistani partner university". Page 34. "...sustainable and productive, long-term linkages between ASU and the Pakistani universities". Page 74, Cooperative Agreement.

- National Energy Efficiency and Conservation Authority (NEECA): Energy technology in brick kilns.
- Fauji Fertilizer Company (FFC).

This is not an exhaustive list. Some of these linkages are highly strategic in nature for their policy dimension and / or promotion of public-private partnership in energy sector. The assessment team therefore views these examples also from the lens of longer-term sustainability of USPCAS-E initiative.

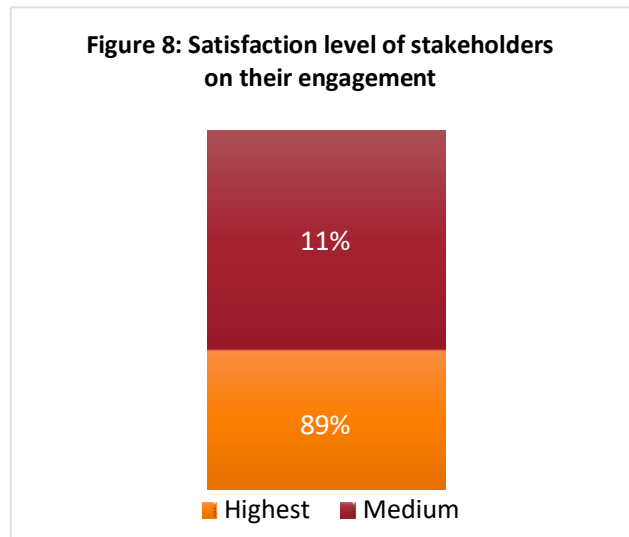
4.3.6 RATING OF NETWORKING BY THE STAKEHOLDERS

Face to face workshops, conferences and virtual seminars have been appreciated by all the respondents (Figure 7). These events also add to networking portfolio and acquire visibility for the USPCAS-E initiatives. In case of students, pre- and post-tests are conducted to see learning impact. Each graduate is tracked. External stakeholders are always on board in the workshops at the invitation of ASU. Respondent from Alternate Energy Development



Board also supported these views by highlighting need for developing alternate source of energy development. NEECA also appreciated ASU’s exceptional support in research.

The external stakeholders were also asked about their satisfaction regarding the efforts of ASU on stakeholders’ engagement and ensuring that their participation remains engaging and interesting. Based on the evidence that several important stakeholders were mobilized to engage in activities including research collaboration, as well as stakeholders’ own feedback to the study team (Figure 8), it is evident that ASU’s engagement with stakeholders has remained highly satisfactory. This goes in line with the indicator of USPCAS-E sustainability that several essential external stakeholders may be mobilized and gradually shift their roles to become major actors in favor of USPCAS-E initiatives. This will however require continuous collaboration efforts and generating demand for USPCAS-E to conduct applied research on the challenges dealt with by these stakeholders.



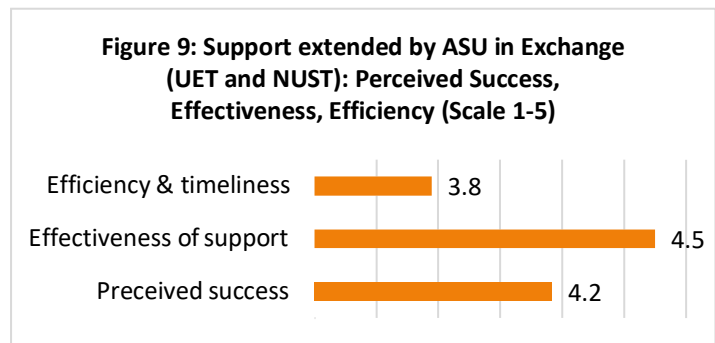
4.4 KNOWLEDGE EXCHANGE AND COLLABORATION

Students' Exchange program to Arizona State University (ASU) seems to be a central and most favored component among all the internal stakeholders and has received high degree of ranking. ASU support is considered phenomenal in preparing for exchange visits since lots of logistical details are involved in making arrangement, preparations and providing guidance for exchange. This section analyses different perspectives (faculty, PMU staff, students) at both universities regarding effectiveness of exchange program.

4.4.1. UET AND NUST FACULTY AND PMU PERSPECTIVE

The respondents stated that this component evolved with feedback from various batches visiting ASU. The students acquire learning opportunities, are exposed to new skills, exposure, and gain a lot of confidence and qualification for scholarships (e.g. Fulbright). The exchange serves grooming opportunity since for many students it is the first time to be in any international university. Lab facilities are excellent. Faculty experienced

that exchange students' ability to make presentations and write papers was noted to have improved. Many have published papers on return from exchange. NUST faculty stated that the students are sent for exposure after 3rd semester when they are 4 months advanced with their research projects and make full benefit of lab facilities at ASU. Faculty members indicated two main benefits for themselves from joining exchange visits: Networking, and exposure to instruction methodologies. For them the 16-week period for exchange was not enough for research. They have rated an overall success of this component at 4.2 (on a scale 1-5), effectiveness at 4.5 and overall efficiency and timeliness at 3.8 (Figure 9).



The observations shared by these groups are analyzed below:

- The most frequent feedback was on role of faculty members joining the exchange students. The exchange program is students and not faculty-centric, hence did not add value to faculty's skills in a significant way.
- The PMU at NUST added, if faculty have no chaperon role, what then their expected role to accompany the students was? Exchange plan is designed keeping students in mind and there are no planned deliverables for the joining faculty which render the exchange ineffective for faculty.
- One faculty member added that the exchange has networking benefits. It depends on individuals' own networking abilities. If joining faculty desires to meet relevant ASU faculty, it is welcomed and arranged through ASU administration, however brief.
- Students' interaction with foreign students is missing. Hence an important opportunity for inter-cultural exposure is missed. Opportunity interactions in the labs with foreign students are limited.
- Separating supervisor and students in different labs has happened in few cases. This is being addressed so that one research group remains together.

- f. Most of the course is lab oriented. Labs are vast, well equipped and useful with rich experimental choices. However, there are long ques to wait and alignment issues emerge with labs assigned to the students.

4.4.2. UET/NUST STUDENTS' PERSPECTIVE

All the students stated that exchange was highly effective and useful in contributing to building their confidence in a multi-cultural environment. At ASU students gain hands on experience and pitching ideas for the market. One student stated, "It is a training on research methods. So that we are prepared to conduct applied research on any topic of our choice when we come back. The core focus of exchange is on improving skills. I feel I can use my skills in my research and work much faster with confidence." 100% students admired an excellent logistical support in preparing for the exchange. Selection of students was reported to be transparent.

The students' shared following observations on exchange program:

- a. 100% exchange students stated that they did not feel well prepared for the exchange program (e.g. pre-discussing their interest with an assigned supervisor, align their expectations and determine expectations). A few students took the initiative to contact ASU to pre-identify a research idea. However, they could not follow up on this since everything was pre-scheduled with too many activities and less time for research.
- b. Incompatibility of lab assigned was the main frustration for most of the students. A change on spot was often not accommodated.
- c. The students at UET shared that no targets are assigned to the students for research. They spend their time only in familiarizing with tools, know-how, and follow a fixed program in a pre-assigned lab. The timing is premature for UET students to go to ASU after 2nd semester when they have not prepared any research idea. The students were adjusted in ready research projects prepared for the course. NUST students are sent after the 3rd semester and they can link their exchange better than UET students.
- d. Different members of faculty have different approaches. Few have a stronger relevance for Pakistan. Hence, the exchange serves as an exposure and not an aide to the degree course.
- e. Students feel that lectures and theory sessions may have added a lot of value and add discussion-oriented learning environment during stay at ASU.
- f. UET students also regret that they were not taught research methods before leaving for ASU exchange. Therefore, their ability to understand instruction at ASU remains a struggle.
- g. At NUST, only GPA-centric selection of students for exchange excludes the chance for students with better leadership qualities, published papers, humble background or gender.
- h. The students indicated that the exchange did not count to degree grades. 25% students believed that despite this, the course was useful in competence building and improve research methods back home.
- i. 100% students at UET shared that gender considerations were important in selecting students for exchange. In case of NUST it is purely merit based.

4.5 SUSTAINABILITY

All the targets assigned to ASU for sustainability component have been fulfilled as indicated in chapter 2. However, the effectiveness of these activities and results will prove only when UET and NUST build on these in

future and remain dynamic. Sustainability of the Centers is a core subject and challenge. This section captures the discussion held with stakeholders on sustainability.

Both the Centers have their own history and strategies to sustain themselves beyond USAID support. According to the stakeholders interviewed at NUST, all the basics have been achieved at NUST for sustainability. The Center is fully integrated into NUST and staff employed by NUST. PMU will cease to exist, however NUST plans to retain institutional memory by placing interested PMU staff in different suitable positions within the university. There are 19 such Centers at NUST, hence USPCAS-E is not a burden on the university. UET is struggling to determine if this should become a department integrated in the UET or acquire status of Center of Excellence with an independent status, own Board of Governors, and affiliation with the UET. For the Center to continue as a dynamic institution and generate its own funds, it has to acquire a status of independent institution like the Water Center at Mehran University in Sindh and the International Center for Chemical and Biological Sciences in Karachi (<http://iccs.edu/>). There is an opportunity at UET for continuity of faculty. UET has started recruitment process for engaging faculty on the university pay scales. The call is open for all qualified candidates. In case the experience in joint/applied research in relevant fields is also weighted high along teaching experience, the existing faculty may have a higher chance to be retained. If not, the existing faculty may be replaced by candidates with more publications and academic experience.

The study team recorded key ingredients of sustainability comprehended in the Cooperative Agreement¹⁴.

4.5.1. OWNERSHIP FROM THE GOVERNMENT

1. Government seems to be 100% convinced and interested in both institutions to continue and is ready to support. More examples have been reported from UET:
 - a. The Chief Minister Khyber Pakhtunkhwa, Speaker Khyber Pakhtunkhwa Parliament, the Chief Secretary, and the Additional Chief Secretary (ACS) are highly supportive of continuation of the Center. The ACS reportedly requested USAID for a No Cost Extension (NCE) seeking a bridge towards finding a permanent solution for the Center. Whether the NCE is granted or not, this reflects a high level of ownership of the government to sustain Center at UET by finding a good solution within the extra time borrowed from USAID.
 - b. Meeting with Speaker Khyber Pakhtunkhwa Assembly led to the discussion that the annual financial requirement of the UET will be budgeted in the upcoming Annual Development Plan for 2020.
 - c. The Khyber Pakhtunkhwa Oil and Gas Company and PEDO are promoting public private partnership in energy sector. UET may play a role in developing proposals for partnership (innovations).
 - d. Government of Khyber Pakhtunkhwa Energy Department have also expressed their commitment towards continuation of USPCAS-E at UET.

2. Higher Education Department (HED) Khyber Pakhtunkhwa reflected that their interest in USPCAS-E UET continuation is very high but it was a very short period since 2017. Building sustainable institutions takes

¹⁴ The sustainability of each CAS will rely on several key factors: (i) Government leadership / ownership (ii) The ability of each Center to raise revenues (iii) enduring partnerships with top ranking universities outside of Pakistan. Cooperative Agreement, page 33.

time. The HED shared that PKR 40 million grant was approved for establishing solar testing lab and added, “We are giving a high value to this Center since it has a potential to earn for themselves and employ more youth. The Center needs to work on its promotion and visibility; has a potential to support the government in policy making issues on energy and may serve as a role model for other universities.”

The question of ownership by the government is closely linked with USPCAS-E establishment as robust institutions. The stakeholders highlight the following elements for a stronger institutional sustainability:

1. USPCAS-E need to acquire a strong problem-solving approach and ability to offer real life solutions and questions faced by the industry. For this, capacity building of researchers and faculty is a must. ASU’s potential role could be to conduct training needs assessment of researchers from this angle so that they are able to fulfil the expected roles.
2. Globally accepted certifications and accreditations may be included in capacity building plan for researchers as well as labs.
3. One faculty member stated that faculty has also grown along with USPCAS-E. In a usual scenario, PhD is a must for qualifying to become a faculty. However, the fields where USPCAS-E is to flourish are new and is evolving with young graduates. Hence technical experience and exposure are also to be considered important for qualification rating.
4. Both NUST and UET need to follow policy evolution in energy and industry sectors. They need to be prepared for addressing policy priorities and quickly adapt their offers.
5. There needs to be stronger inter-departmental synergy especially within NUST. This will reinforce and strengthen USPCAS-E’s presence to the external stakeholders.
6. It is also important to encourage exchange among the two universities – not just with US universities. Joint projects among the two may render a lot of learning and strong national image.

4.5.2. ABILITY TO GENERATE AND RAISE REVENUES

As stated by HEC stakeholder, sustainability is not just continuing as an isolated center or acquiring enough funds – it is about dynamic search for sustainable and concrete public-private partnerships (PPP). The need for effective PPP has been identified as a precursor for revenue generation by all the external stakeholders interviewed for this study. With intensive support from ASU, several linkages were established with a variety of clients (see Chapter 4). The Cooperative Agreement however sees the need for more long-lasting linkages and revenue generation through collaborative work. Collaboration with PESCO and NTDC for instance has such potential which may be harnessed by both Centers. The stakeholders however are concerned that industry is not research driven and does not see academia as a partner. In such an environment, an additional role of USPCAS-E is to create awareness in this sector by offering cost-effective models. The most rewarding offer in this regard may be in the field of energy efficiency as suggested by most of the external stakeholders. They also highlighted that modern high-quality labs may further attract such joint ventures and attracting clients for raising revenues. It is encouraging to note that both UET and NUST have acquired funding opportunities, especially in applied research, from multiple sources. ASU’s support is highly evident since most of this was achieved through mobilizing clients and duty bearers in energy sector in the country:

1. UET

- Energy department FATA for solarization of FATA, PKR 400 million – 100% lobbying support came from ASU including writing of the PC1.
- PKR 40 million from Higher Education Department (HED) for solar testing lab. 70% lobbying support came from ASU.
- Labs are ready, operational with good instruments, and can function for funds generation. Major actors in the industry already know that Center has built own capacity with good equipment and access to labs relevant to needs.
- UNIDO is keen to work with UET with little start of US\$80,000(biomass).
- PESCO is negotiating for transformers' management and repair. However, this will require additional capacity.

2. NUST

- Research labs serve a strong sustainability strategy as paid testing facilities for interested clients.
- Consultancies, e.g. with NTDC, FFC (80% fee for the consultant, 10% for USPCAS-E and 10% for NUST).
- 250 kw PV plant based on power generation capacity potential to earn 4-5 million annually. Its capacity is being increased.
- Projects have been financed by Pakistan Science Foundation (PSF), Fauji Fertilizer Company (FFC) and HEC. The HEC has already approved a project of US\$ 1million.

Branding the centers and what they offer including labs (and how and on which terms these labs may be accessed etc.), is urgent and important. Technology in Pakistan can go rapid transformation if economic activity, as promised by the government, increases. Stakeholders expressed their concern that a much stronger industry liaison is necessary to ensure continuation of the Center functions. Except for few faculty / research fellows motivated by ASU, others are not proactively investing their time in this task. One of the stakeholders stated, "USPCAS-E will have to go to the industry, the industry will not come to them." ASU has made immense efforts to bridge this through active networking (see Figure 8) and interns' placement at the industry and through preparing sustainability plans.

4.5.3. INTERNATIONAL COLLABORATION

It is stated in the Cooperative Agreement, ... CAS sustainability will also depend on the establishment of enduring partnerships with top ranking universities outside of Pakistan (in this case US universities)... It is important to analyze progress on this. Certainly, once USAID withdraws its support, it is up to USPCAS-E at the two universities and the international partner universities to continue and explore resources to finance most useful activities. One of the stakeholders expressed that continuation of some collaboration (e.g. joint research) and new ideas of cooperation (e.g. joint degree program) may be useful in the future. Other internal stakeholders expressed their wish to continue collaboration as follows:

- Reduced exchange program for students only (even with 20% of the current intensity).
- Joint research on energy-mix and diversification (wind, solar, hydro).
- Joint submission of project proposals.

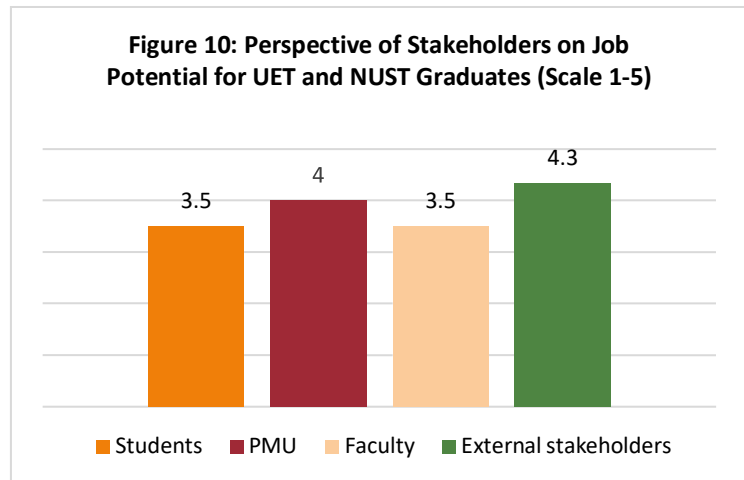
Stakeholders from HEC and HED highlighted the need of university to university collaboration based on thematic alignment within and outside Pakistan and not limited to US based universities. Energy is a growing field in Pakistan and therefore opportunities will be numerous in future.

4.5.4. JOBS PROSPECTS FOR PCASE GRADUATES

Although not indicated in the Cooperative Agreement under ASU's domain, improved job prospects, is reflected as a secondary branding message and an effect of USPCAS-E sponsorship to universities¹⁵. The assessment team came across some interesting discussion that is recorded here for the benefit of stakeholders. High induction of students in jobs based on their degree from USPCAS-E indicates demand for these competences in the market and the credibility of the institutions and their alumni.

Figure 10 presents that the students and faculty members see a medium to high chance for the students to find jobs based on their degrees, whereas PMU and external stakeholders are more optimistic (with high rating of 4 and 4.3) in this regard. NUST reported that 73% graduate students are employed (this includes interns and students on higher studies). Female students are included in this figure. The students however challenged that their alumni colleagues got the jobs based on their BE degrees.

Some of the most important perspectives recorded are as follows:



Students and Faculty

1. Most industries try to manage their functions by hiring lower qualified personnel (e.g. B-tech and at the most BE). Most industries try cheaper solutions by replicating or copying existing models and do not try to create or innovate technologies since this requires R&D and tailoring technology to their need. A culture of R&D does not prevail in most of our industry.
2. Since competition for jobs is quite tough, just BE is not enough. USPCAS-E provides opportunity to improve qualification, grooming, communication skills, networking and hence higher chances for jobs.
3. Primary job criteria may be determined by BE (main eligibility) and Masters' degree brings additional points. New qualifications are not widely known hence not prescribed in advertisements.
4. "Energy Management and Policy" degree is a big question mark. There is no explicit demand in the sector for these students. However, it is not excluded that this is highly needed field in Pakistan.
5. The industry needs to know the skills available in the graduates are why they may be better than others in the energy sector.

¹⁵ By acquiring the ability to conduct applied research for industry and policy makers, engineering students can enhance their job prospects and their capacity to contribute to Pakistan's economic growth. Cooperative Agreement, Page 75

6. More effort is required by both Centers to polish students (for jobs or for self-employment) through more practical engagement.

Private sector perspective

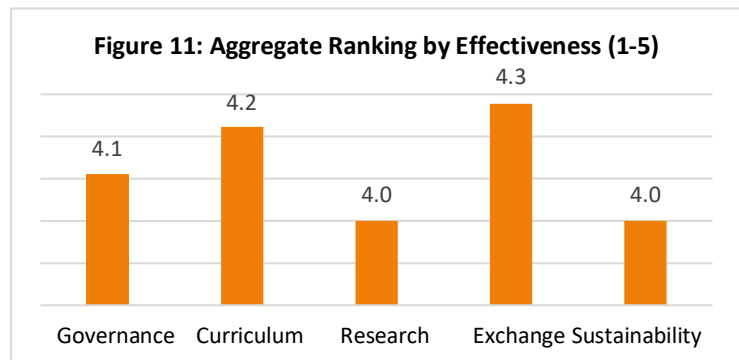
1. There should be no doubt in demand for these students! BE students after graduation often try to find internships to acquire better hands on skills. UET and NUST provide a kind of internship to polish their skills, equip them with more knowledge practical know-how.
2. Another respondent viewed that the market does not recognize this degree. USPCAS-E at both places need to publicize their institutions and the graduates / graduation streams.
3. The ones with BE degree have a vertical knowledge, whereas Masters' students have horizontal knowledge and good networking with other related disciplines that can help them open their minds and strategic thinking. With this additional knowledge their demand will be higher.
4. There is a need to conduct a study on job forecasting for Pakistan in energy sector. The government desperately needs ideas and planning in energy sector. Students must not only target private sector, the government and government owned companies may be a big possibility.

Public sector perspective

1. The university and HEC need to work with Public Service Commission and Provincial Commissions for recognition and inclusion of the degrees in future calls.
2. The Centers need to conduct impactful applied research by engaging students and alumni in collaboration with clients. This will generate demand for the students.
3. There are no well-defined jobs for such graduates in the country yet. Both UET and NUST need to put pressure on major employers including government to create and evolve demand for such graduates.

5. OVERALL SATISFACTION ON ADEQUACY OF ASU SUPPORT

In an aggregate assessment, all five components were analyzed in terms of effectiveness of support on a scale 1-5 (5 being the highest). The highest in this regard is Exchange (4.5) followed very closely by curriculum reforms. Governance and research come next with 4.1 and 4.0 respectively at high level. Sustainability stands at 3.9 with a trend from medium to high (Figure 11.)



The respondents were asked several questions on individual components of support (Annex 5) and based on this discussion and ranking in multiple places, they were asked to give their candid opinion on overall satisfaction for adequacy of ASU support.

An aggregate percentage (UET+NUST, Figure 12) of stakeholders highly satisfied with adequacy of ASU support in all the components is 78% whereas 22% rated the same at medium level (of which 60% are students).

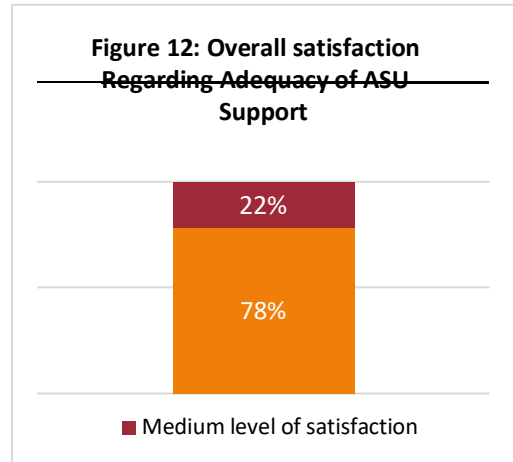
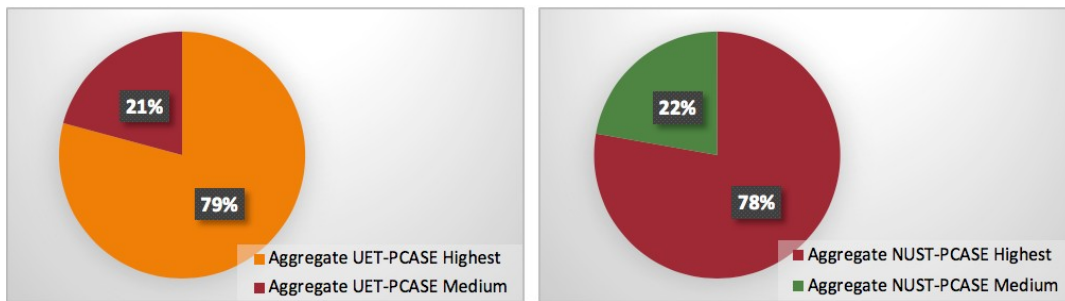


Figure 13 presents segregated pictures of assessment from PMU staff, students, and external stakeholders of each Center. The graph also presents an aggregate figure for UET and NUST. None of the stakeholders rated low or zero for their satisfaction level for adequacy of support. At UET, an aggregate percentage of highly satisfied respondents is 79% whereas 21% (all students) rated their satisfaction at medium level. At NUST, an aggregate percentage of highly satisfied respondents is 78% whereas 22% (of which 57% are students) rated their satisfaction level at medium (Figure 13).

Figure 13

Overall satisfaction Regarding Adequacy of ASU Support –Stakeholders’ Aggregate Perspective



The following graphs present segregated perspectives from PMU+ faculty, students and external stakeholders at each PCASE (Figures 14, 15 and 16).

Figure 14:

Overall satisfaction Regarding Adequacy of ASU Support –PMU + Faculty Aggregate Perspective

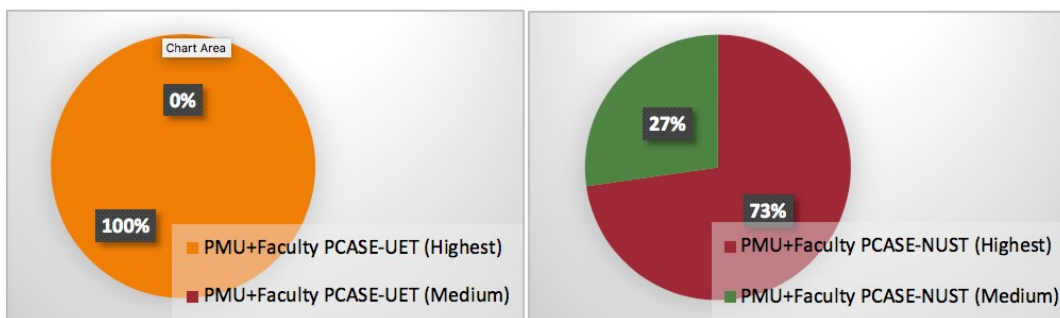


Figure 15:
Overall satisfaction Regarding Adequacy of ASU Support –Students’ Aggregate Perspective

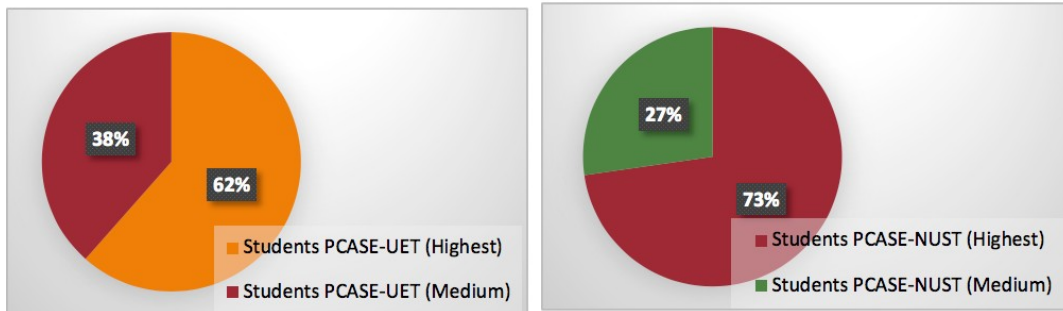
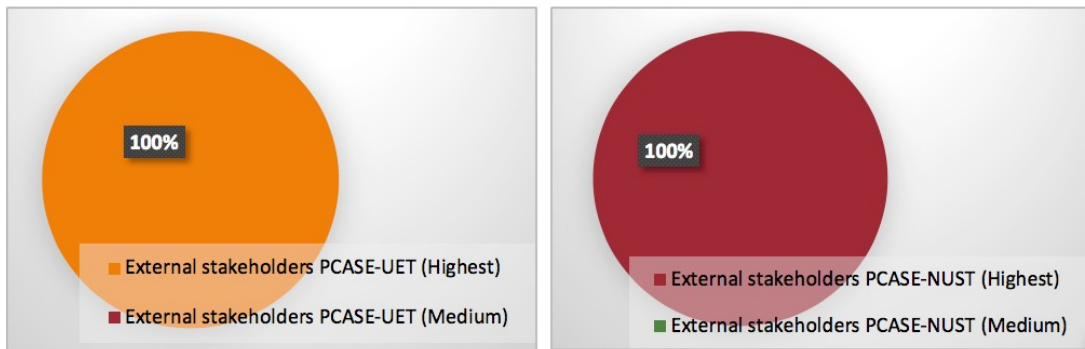


Figure 16:
Overall satisfaction Regarding Adequacy of ASU Support –External Stakeholders’ Aggregate Perspective



6. OVERALL CONCLUSIONS OF THE ASSESSMENT

Following internal and contextual challenges were identified by the study team in various discussions:

1. USPCAS-E project and ASU support arrived in 2015 when the context was still quite challenging with regional insecurity and visibility had to be extremely low (especially Peshawar).
2. UET faced a special situation and therefore ASU took operational responsibility of the matters and committed to catch up with targets within a limited time (2017-2019).
3. Subject specialists in the relevant fields of USPCAS-E interest were not easily available within Pakistan and hence establishing the right set of human resource was the first challenge to deal with.
4. Technical Advisor for NUST is based at ASU and is challenged by distance and limited contextual experience. UET had a local Technical Advisor and readily available to the team.
5. Procurement process for labs were at times very slow and caused delays in making the labs operational on time.
6. Industry is not research oriented and therefore cultivating demand for USPCAS-E services remained a challenge and up-hill task.

Within this context, ASU support for making the project successful both at UET and NUST has been phenomenal and up to the mark.

6.1 OVERALL

- All the internal and external stakeholders both in Peshawar and Islamabad have recorded a high level of appreciation for ASU support in all five components and even beyond. ASU has gone extra mileage to address emerging issues and needs with a flexible approach.
- An overall percentage (UET+NUST) of stakeholders stating that they are highly satisfied with adequacy of ASU support is 78% whereas 22% rated the same at medium level (of which 73% are students who had limited exposure to all the components). At UET, an aggregate percentage of highly satisfied respondents was 83% whereas 17% (students) rated their satisfaction level at medium.
- At NUST, an aggregate percentage of highly satisfied respondents was 78% whereas 22% (of which 57% are students) rated their satisfaction level at medium.
- None of the stakeholders rated low for their satisfaction level for adequacy of support.

6.2 CONCLUSION ON FIVE SUPPORT COMPONENTS (SCALE 1-5)

6.2.1 GOVERNANCE

It is evident that ASU provided immense support in this component and at times beyond their original mandate ensuring adaptive planning by addressing emerging challenges. All mandatory activities have been implemented and the relevant structures are performing.

UET: The overall perceived success of this component in terms of targets was 4.4. This support was rated as highly effective (4) and was delivered in an efficient manner (4.1). The respondents have rated these indicators considering the fact, that the UET is not yet there at acquiring fully independent governance that can function on its own without technical support from ASU and financial support from USAID – this discussion has been recorded in the section 4.5 in the report.

NUST: The successful achievement of this component was rated at a high level by all the respondents (4.3). The efficiency of support is rated at 4.6 and effectiveness at 4.2 (medium).

6.2.2 CURRICULUM REFORMS

Curriculum support was rated at 4.1 (very high) in terms of overall success in targets' accomplishment. It was rated highly effective (4.2) and delivered with high efficiency and timeliness (4.6). This support was crucial since without all necessary timely approvals, degree courses would not have been launched in time. Hence all the support for necessary preparation, consultations, feedback from ASU experts and lobbying on curricula to improve quality were highly appreciated for their effectiveness and timeliness. Some of the faculty members expressed, that in future feedback on curriculum content may be more explicit for creating learning impact.

6.2.3 RESEARCH

The respondents rated overall success of research component at 4.0, effectiveness at 4.5 and timeliness of support at 3.9 (medium to high). They appreciate networking effort of ASU with clients which helped enhancing applicability and relevance of research projects.

6.2.4 EXCHANGE

An overall success of this component was rated at 4.2. Overall effectiveness was rated at 4.3 and efficiency and timeliness at 3.8 (medium to high). The students and faculty visitors' perspectives were rather similar – yet this component remained highly effective and relevant for the students rather than faculty. The main area of improvement in this component is to align students' priority with ASU faculty and lab assignment. The long duration of exchange for teachers was not deemed useful.

6.2.5 SUSTAINABILITY

Sustainability was assessed only in a qualitative sense. The targets set for ASU are process oriented and the progress is on a good track. All six identified ingredients are well on track due to an extensive, punctual and sincere support from ASU towards UET and NUST. These include ownership of and engagement with government, institutional strengthening (partly addressed through strengthening governance), public-private partnerships, fund raising and increased job prospects for the graduated students. International collaboration needs to be firmed up for a longer-term relation. USPCAS-E need to perform and undertake rigorous effort in all these areas on a steep learning curve.

Some of the additional critical conclusions are noted here which may determine the remaining course of ASU's advisors' engagement with both the universities.

1. The international connectivity of the Centers will decrease once ASU and USAID support ends. Joint research and exchange opportunity will suddenly diminish. This will negatively impact motivation of the faculty and students. What are the future thoughts on this and whether any means have been secured to maintain international linkages?
2. It is not yet clear how the continuation of efforts for industry liaison and marketing of USPCAS-E will be ensured when PMU and ASU are not there? Do the university statutes have provisions to recruit staff for such functions? These are critical questions if these Centers are to become service-oriented and self-sustained. With a status of a regular department of the university this may become challenging.
3. There is an opportunity at USPCAS-E UET for continuity of faculty since UET has started recruitment process for engaging faculty on the university pay scales.

7. RECOMMENDATIONS

7.1 FOR THE REMAINING LIFE OF PROJECT

1. A workshop involving all important stakeholders to offer a platform to acquire clarity on USPCAS-E UET future and structure. There is not much time left to decide on the future of the Center as an independent institution governed by a Board of Directors (e.g. center of excellence) or department of UET.
2. Continue to help the USPCAS-E initiatives finding new sources of funding including with multi-lateral and development donors (sustainability). Other means (such as labs, consultancies) will take time to generate required funding to continue the Centers' function at current quality. In the absence of additional funding students would pay full fees and joint research will seize for some time. With full fee, enough enrolment to run a degree program is not ensured.
3. Advocate for corporate partners' formal representation within the governing structure of USPCAS-E.
4. Explore international connectivity – e.g. opportunities for a joint degree program with ASU, funding for joint research, etc.
5. Complete procurement and establishment process for labs.
6. Motivate USPCAS-E for seeking required accreditations and business plans
7. Create awareness in corporate sector for R&D and need-based solutions (recommendation for PMUs at each partner university).
8. Organize brainstorming sessions for USPCAS-E on long-term partnership strategies based on comparative advantages of these centers by mapping demand and offers. These may be shared with external stakeholders in a workshop environment.
9. Support USPCAS-E at both places to prepare a marketing and branding strategy to attract funds.

7.2 FOR FUTURE REPLICATION OF SIMILAR INITIATIVES ELSEWHERE

1. Exchange opportunity in future be made flexible in terms of assigning labs and giving research assignments while at ASU.
2. Ensure opportunities for the students to interact with other international students while at ASU.
3. Student's participation in exchange may be more useful after they have completed their research proposals.
4. Opportunities to attend credited courses at ASU so that time spent is rewarding and more productive.
5. In future, publicity campaigns of services possibly provided by such Centers must be embedded in the project documents and work plans.

ANNEXES

ANNEX 1: WORK PLAN FOR THE ASSIGNMENT

Week / month		Task
December 18	Week 2	Review documents / secondary material (This will continue during the entire course of the study)
		Inception meeting with ASU focal person
	Week 4	Organize inception report and draft data collection tools
January 19	16 th	Initial meetings with ASU staff and primary stakeholders in the universities and prepare draft stakeholders' map and analysis
	20 th	Furnish final inception report along data collection tools
	30 th and 31 st	Conduct FDGs and first round of key informant interviews <ul style="list-style-type: none"> CAS-UET Peshawar □
February 19	1 st and 2 nd February 4 th – 6 th February 7 th to 13 th February	<ul style="list-style-type: none"> Stakeholders' meetings Peshawar CAS-NUST Islamabad Stakeholders' meetings Islamabad, Peshawar
	February 9 th – 19 th	<ul style="list-style-type: none"> Data analysis (quantitative and qualitative) and narrative notes Preparation of draft report Continue with data collection and conduct mini workshops
	20 th February 25 th February	<ul style="list-style-type: none"> Initial debriefing with ASU on draft report Submit first draft for ASU comments followed by a workshop with ASU, NUST, UET and key stakeholders to share findings and acquire feedback
March 19	5 th March	<ul style="list-style-type: none"> Finalize report (final date of submission will be adjusted as per feedback received) <p style="text-align: right;">End of assignment / sign off</p>

ANNEX 2: DESCRIPTION OF SUPPORT COMPONENTS FROM ASU

This Annex section describes key parameters of the support expected to be provided by ASU in five areas, and in how far these could be achieved.

1. Sound Governance, pertaining with the establishment of the Center
2. Modernized and specialized curriculum development in energy
3. Exchange and scholarship programs and new teaching strategies and methods
4. Applied and Joint Research Projects, and,
5. Activities related to the long-term sustainability of the centers

The information included in this Annex is derived from progress reports of ASU and verification during interviews with stakeholders. For analysis, the study team has benefited from additional information provided and observations made by the ASU and PMU teams at both the Centers.

1. Governance

According to the Cooperative Agreement, the primary objective of this component is to foster collaboration among partner universities and HEC to develop governance structures that clearly define roles and responsibilities for all PCASE functions, as well as how the PCASE fits within the existing governance structure of both its host universities to allow for institutionalization and sustainability of each PCASE¹⁶. The extended objective of this component was to propel the case and appetite for replication of similar centers in the future by stimulating a national discussion on the level of higher education governance and development. The **mandatory technical assistance activities** for ASU to perform with partner universities under this component and achievement are:

1. In conjunction with the HEC and ASU, assist PCASE partners to establish and/or activate and lead a PCASE Advisory Committee that includes members from each of the PCASE universities, the private sector and relevant government stakeholders that will meet 2-4 times a year to discuss progress, problems and make recommendations as necessary.
2. In conjunction with PCASE partner(s), establish a PCASE Steering Committee at the individual university partner led by the Vice Chancellor and leadership of the PCASE, including key department, private sector and other stakeholder representatives.
3. In conjunction with PCASE partner(s), establish and/or activate a committee on research and policy.
4. Support the establishment of a Project Management Unit within each PCASE to facilitate and monitor the implementation and performance of the PCASE program in a participatory way.
5. Make recommendations and provide technical assistance to respond to needs identified through a self-assessment conducted by each of the partner universities to assess their institutional capacity.
6. Organize a series of workshops, conferences and/or short-term consultancies to assist PCASE partner(s) to inform the development of university-level PCASE strategies, an annual Work Plan, and an overall implementation plan in all component areas.
7. Provide training and/or technical assistance to support the efficiency, transparency and sustainability of grant making and other financial processes managed by Pakistani partner university.
8. Support PCASE partner(s) to develop initial agreements to establish the essential ground rules for the governance of the PCASE projects.

¹⁶ Page 27 Cooperation Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

Based on the above-mentioned mandatory activities, the ASU has achieved the following targets under the Governance component:

	Targets	Achievements
1	Establishment of Advisory Committee	Advisory committee established and functional
2	Establishment of Steering Committees at each PCASE	02 steering committees established and functional
3	Establishment of Research and Policy committee	Research and Policy committees established and functional at each PCASE
4	Establish PMUs at each PCASE	PMUs established at each PCASE and functional
5	Provide technical assistance to respond to needs for improved institutional capacity	Achieved - discussions with stakeholders reflect that this is a continuous process
6	Organize a series of workshops, conferences, consultancies	Achieved - This is a continuous process
7	Training and/or technical assistance to support the efficiency, transparency, sustainability of financial processes	Achieved - discussions with stakeholders reflect that this is a continuous process
8	MOU signing with HEC, ASU, NUST and UET	MoU signed

2. Curriculum development and reform

According to the Cooperative Agreement¹⁷, the curricula offered by each PCASE are expected to include broadly transferrable skills that enhance graduate competitiveness. Appropriate IT based means were proposed to increase equitable and quality access to instruction. The process defined under this component included, (i) involvement of both PCASE faculties and staff with input from HEC, ASU, and government and business community stakeholders, to review existing degree programs and courses, identify areas where they are outdated or irrelevant to public and private sector needs, and determine which new courses were needed (ii) HEC and the curriculum committee of each partner universities will be involved in vetting process of recommended course contents (iii) Course syllabi will then be developed that include options for applied and/or policy research and internships. ASU was expected to give support in designing a complete package of curriculum reforms, however, the authority to approve, adopt and accredit the proposed reforms rested with the universities' leadership and HEC. ASU was expected to provide the following mandatory technical assistance to the partner universities:

1. Support creation of a curriculum development working group at each PCASE university with sub-committees for subjects and courses as appropriate. These committees will include stakeholder representation.
2. Assist in launching of existing university curriculum committees as needed to improve the variety and quality of coursework (including across sectors) offered by the partner universities.
3. In collaboration with the partner universities, HEC, and public and private sector stakeholders, develop graduate and postgraduate training policies and plans to support PCASE provision of advanced research and experiential learning opportunities linked to qualitative improvements in teaching, curriculum and research. Plans will have quantitative as well as qualitative results and benchmarks.

Based on the above-mentioned mandatory activities, the ASU has achieved the following targets under the curriculum reform component:

#	Targets	Achievements
1	Establishment of Curriculum Development Working Group. Assist improve the variety and quality of coursework	Curriculum Development Working Group established and functional at each PCASE

¹⁷ Page 9, Cooperation Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

2	6 new professional certificate programs (3 NUST and 3 UET)	13 new professional degree certificate programs developed (NUST 7 and UET 6)
3	40 new courses (NUST 20 and UET 20)	157 new courses developed (NUST 73 and UET 106)
4	O2 libraries	O2 libraries established (1 each at UET and NUST)

3. Joint and Applied Research

The core aim of this component according to the Cooperation Agreement was to encourage and catalyze research focused on emerging market demands and anticipated societal challenges pertaining to energy and economic growth within the overall US-PCAS-E scope of support in the country. The work of PCASE faculties and students must meet the need for high quality, advanced applied research¹⁸. The researchers are expected to internalize a new mindset away from overly theoretical concepts toward innovative applied research solutions that are both sensible and sustainable. Applied research requires relevant private sector and government stakeholders to get engaged in developing PCASE research agendas to ensure relevance to their needs. Such research, if relevant to the needs of private sector, may attract funding from private sector. As part of this component, laboratories and libraries were to be improved to bring them at par with modern standards, including communications and IT innovations to promote effective research. ASU was expected to extend the following mandatory technical assistance to partner universities under the research component:

1. Support partner universities to organize stakeholder meetings to set applied research agendas.
2. Labs and libraries:
 - a. Supplement the materials available to purchase additional equipment needed for laboratory, research and library equipment and materials and assist university partners to develop plans for laboratory and library improvements.
 - b. Assist partner universities to assess and propose to USAID any ‘brick and mortar’ library and laboratory upgrades to be built through USAID’s construction contract.
 - c. Procure and deliver laboratory equipment to enhance the productivity of each PCASE.
3. Convene policy dialogues among key stakeholders.
4. Conduct applied research in collaboration with the partner universities.

Based on the above-mentioned mandatory activities, the ASU has achieved the following targets under the Research component:

#	Activity target	Achievements
1	Organize stakeholders’ meetings	A regular feature of support (5 meetings held so far)
2	Labs and libraries	18 Dedicated labs established (8 UET and 10 NUST) 2 libraries established (1 at each PCASE)
3	Convene policy dialogues among stakeholders	A regular feature of support
4	30 Applied research projects (15 each at NUST and UET)	36 (NUST 14 and UET 22)
5	10 joint Research projects (NUST 5 and UET 5)	12, (NUST 6 and UET 6)

4. Knowledge exchange and collaboration

As noted in the Cooperation Agreement, in collaboration with US university counterparts (ASU), PCASE faculty will increase the prevalent use of effective teaching techniques and applied learning opportunities that promote critical thinking. This component emphasizes extensive short-term study and exchange programs for professors and students, as well as scholarships and internship opportunities. The Cooperation Agreement intended that within the PCASE degree programs, students will acquire the opportunity to attend the courses at ASU¹⁹. The training will be for master’s and post graduate

¹⁸ Page 31, Cooperation Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

¹⁹ Page 32, Cooperation Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

students including non-degree coursework or other structured learning opportunities in high priority PCASE specialty-related technical areas, policy development and research. Most importantly, training will be geared toward creating high quality graduates possessing the skills needed by public and private sectors. ASU's mandatory activities in technical assistance to partner universities regarding exchange included the following:

1. Develop graduate and post graduate (i.e. masters level and above) short-term training and exchange programs at each PCASE for students and faculty.
2. Organize workshops and exchanges at ASU to institutionalize the use of effective, experiential teaching techniques at the graduate level that promote critical thinking.
3. Develop an internship program with private sector organizations.
4. Administer a transparent merit and needs based scholarship program for the PCASE, according to HEC standard operating procedures and USAID gender equity principles.
5. Organize at least 50 student and faculty exchanges²⁰ to participate in training and/or research at the recipient university. The ASU will need to budget all associated costs related to these exchanges.
6. Support partner universities to issue at least 50 advanced applied research grants over five years

Based on the above-mentioned mandatory activities, the ASU has achieved the following targets under the exchange component:

#	Activity target	Achievements
1	Develop graduate / post-grad exchange program	Achieved
2	Organize workshops and exchanges at ASU (10 technical and thematic workshops)	12 technical and thematic workshops held 7 virtual seminars held
3	Develop internship program / opportunities with private sector	99 (NUST 65, UET 34)
4	Develop / administer merit-based scholarship program	517 scholarships (NUST 267, UET 250 (13% women))
5	200 exchange visitors (NUST 100 and UET 100)	137 exchange visitors (NUST 77- 34% women; UET 60 – 18% women)

5. Sustainability

According to the Cooperation Agreement, the sustainability of each PCASE will rely on several key factors²¹:

1. Government leadership at HEC and each PCASE is essential if project reforms are to survive at the PCASE and spread throughout the higher education system.
2. The ability of each PCASE to raise revenues, commercialize research and make alliances with stakeholders.
3. PCASE sustainability will also depend on the establishment of enduring partnerships with top ranking universities outside of Pakistan (in this case U.S. universities) to exchange ideas, collaborate on research and continue to raise the standards of higher education in Pakistan beyond the life of the PCASE project.

The **mandatory technical assistance activities** for ASU to perform with partner universities under this component and achievement are:

1. Increase the capacity of each PCASE to raise funds from alumni, grant making foundations, and corporates.
2. Build capacity of the PCASE to reach out to the business community and other private sector stakeholders to establish productive dialogue, promote PCASE research services, and market the skills and qualifications of graduates.

²⁰ This target was changed to 100 for each CAS

²¹ Page 33, Cooperation Agreement No. AID-391 -A-15-0000 I – USAID and Arizona State University

3. Develop and implement a robust program of sustainable and long-term collaborative linkages between the ASU / international universities and its Pakistani partner university.

Based on the above, the ASU has achieved the following targets under the sustainability component:

Activity target	Achievements
2 million USD fund raising (1 million at both PCASE)	1.54 million USD raised PCASE-NUST: USD 1.13 PCASE-UET: USD 0.41
Linkage development with stakeholders	379 officials representing 88 various industries, government, academia and private organizations participated in stakeholder meetings
Long-term collaboration with international universities	Current with ASU and OSU. Yet to be determined for post-project scenario

ANNEX 3: PEOPLE AND EXPERTS MET AND CONSULTED

No.	Organization	Name	Designation
1	NUST	Dr. Zuhair S. Khan	Principal
2	NUST	Dr. Bilal Sajid	Assistant Professor
3	NUST	Dr. Rabia Liaqat	Assistant Professor
4	NUST	Dr. Naseem Iqbal	Assistant Professor
5	NUST	Dr. Majid Ali	Assistant Professor
6	NUST	Wajiha Tauqir	Student
7	NUST	Ujala Sarwar	Student
8	NUST	Bushra Hassan	Student
9	NUST	Shehzar Shehzad	Student
10	NUST	Noorulain Ali	Student
11	NUST	Rehan Anwar	Student
12	NUST	M. Naveed Arif	Student
13	NUST	Shah Fahad bin Masud	Student
14	NUST	Nisar Ahmed	Student
15	NUST	Unza Jamil	Student
16	NUST	Ahsan Malik	Student
17	NUST	Naveed Ali	Director Admin
18	NUST	Dr. Hina Kazmi	Deputy Project Director
19	NUST	Fawad Kashan Mir	Industry Liaison Officer
20	NUST	Asim Ayub	M&E Specialist
21	NUST	Javaria Karim	Grants Coordinator
22	NUST	Mohammad Nawaz	Database Officer
23	ASU	Arshad Nafees	DD Technical (UET)
24	ASU	Ahmed Saeed	Deputy Director
25	ASU	Shagufta Jeelani	M&E Specialist
26	ASU	Ammar Yasser	Corporate Engagement Officer
27	ASU	Ahmed Sohail	Technical Advisor UET
28	ASU	Arsal Latif	Communication Specialist
29	UET	Dr. Saim Saher	Assistant Professor
30	UET	Dr. Afaq Qamar	Assistant Professor
31	UET	Dr. Khurshid	Assistant Professor
32	UET	Saqib Marwat	Student
33	UET	Sohail Khan	Student
34	UET	Faisal Nawab	Student
35	UET	Muhammad Ali	Student
36	UET	Maoz Khan	Student
37	UET	Saddam Ali	Student
38	UET	Asfand Yar Ali	Student
39	UET	Mehak Asad	Student
40	UET	Fareeha	Student
41	UET	Adnan Ayb	Student
42	UET	Noor Muhammad	Student
43	UET	Sheraz Khan	Student
44	UET	Inzimamul Haq	Student
45	UET	Dr. Najeed Ullah	Deputy Director
46	UET	Uzair Ahmad	M&E specialist

No.	Organization	Name	Designation
47	UET	Shaista Afridi	Industrial Liaison
48	UET	Mohammad Sohail Barki	Communication Manager
49	IUCN	Azfar Ansari	Programme Officer
50	IUCN	Dr. Abdul Majeed	Water & Energy Expert
	External stakeholders		
51	PESCO	Haider Ali	SDO
52	Higher Education Department Khyber Pakhtunkhwa	Hamid khan	CPO
53	National Energy Efficiency and Conservation Authority (NEECA)	Asad Mahmood	
54	Higher Education Commission (HEC)	Dr. Mehmood-ul-Hassan But	Advisor
55	China Three Georges South Asia Investment Limited	N. A. Zubairi	Senior Advisor and Deputy CEO
56	Alternate Energy Development Board (AEDB)	Dr. Irfan Yousaf	
57	Star-hydro Power limited	Waqar Ahmad	CEO
58	AGES consultants Pakistan	Aziz ul Haq	Partner
59	Coronet Foods	Muhammad Riaz	Manager utilities

ANNEX 4: LIST OF DOCUMENTS CONSULTED

Documents shared by ASU

1. Annual reports 2017-2018
2. Annual workplans 2018-219
3. Awareness and Strategy Building for Gender Equity in Engineering, 2017
4. Briefing note on steering committee
5. Briefing note on Committee of Policy and Research
6. CAS Metrics Overview, 30th September 2018
7. Cooperative Agreement No. AID-391 -A-15-0000 I, Partner Center for Advanced Studies in Energy (PCASE).
8. Council for Research Policy (ToRs)
9. Energy Material Workshop, at Serena Islamabad, Pakistan, 2018
10. Exchange Students/Faculty Feedback Fall 2016
11. Exchange Students/Faculty Feedback Fall 2017
12. Exchange Students/Faculty Feedback Fall 2018
13. Exchange Students/Faculty Feedback Spring 2017
14. Faculty interaction notes
15. Green buildings workshops report, 2016
16. Hydro-Power Workshop at NUST, Islamabad, 2018
17. NUST Steering Committee Notification
18. Organogram
19. Quarterly progress report, April-June 2017
20. Quarterly progress report, April – June 2018
21. Quarterly progress report, July - September 2018
22. Solar Photovoltaic Certification and Reliability Workshop, 2017
23. Stakeholders meeting updated list
24. Strategic Proposal Development, at Serena Islamabad, Pakistan 2018
25. Summary tables from all components - Mandatory Results and Targets, and Outputs and Activities to Achieve the Results
26. Technology Entrepreneurship Workshop Report, September 2017
27. Workshop/Training Narrative Report, Corporate Engagement Training, NUST Islamabad, Pakistan April 19-20, 2018

ANNEX 5: SURVEY TOOL: SEMI STRUCTURED QUESTIONNAIRE KIIS / FGDS CHECKLIST

a. PMUs and Faculties at UET and NUST

This checklist will be used for Key Informant interviews and Focus Group Discussions with PMU staff and faculties at UET Peshawar and NUST. The interviewers will start by introducing themselves and explaining the objective of the study. It will be a learning exercise to improve future operational performance/ support by the donors. This checklist of questions is meant to provide a guideline for the interviews and will be tailored to the knowledge/expertise/position of the respondent by **selecting questions relevant to the person/people being interviewed**. It is not necessary to ask every question to everyone. Looking at the nature of study, it is more appropriate to follow a **qualitative approach**. Therefore, this checklist is mainly based on questions meant for qualitative data collection. In addition, few questions in the checklist will also help in collecting quantitative data, where necessary.

RESPONDENT'S NAME:

RESPONDENT'S TITLE & FUNCTION:

DATE:

LOCATION:

Questions
Opening / warm up
1. What was/is your role in the USPCASE? What is your specific role within your organization?
2. What support was extended by ASU in all five areas stipulated under the US-PCASE
Appropriateness/relevance of the ASU support
3. To what extent are the support activities in line with national demands and government initiatives in energy sector? (Highly, Average, Not Really)
4. To what extent were the University administration involved in the process? (Highly, Average, Not Really)
5. What is the relevance of courses at the CAS for Degree in Energy? (1-5)
6. To what extent this support was relevant to priorities of? (Highly, Average, Not Really) <ul style="list-style-type: none"> a. University b. HEC c. Industry (demand for skilled graduates for jobs)
7. Was the support relevant to the objectives of producing skilled graduates as well as promoting applied research needed to advance the energy sector in Pakistan.
8. Is this support relevant for meeting needs for Applied research? (Highly, Average, Not Really)
9. Ranking by perceived success in implementation of support from ASU: <u>Governance</u> , <u>Curriculum Development</u> , <u>Research and Knowledge Exchange</u> ? (1-5 scale)
10. What priority needs do you think the ASU support is not addressing?
Effectiveness/quality
11. To what extent the targets set by the support were achieved? All, Most, Few
12. How do you evaluate the adequacy & appropriateness of support extended? (Highly, Medium, Low)
13. Assess the level of support received from ASU before, during and after exchange program? 1-5
14. Flexibility of ASU in accommodating students in research labs, participation in workshops. 1-5
15. What support was extended in implementation of joint research projects? 1-5

16. How effective was this support received in implementation of joint research projects? 1-5
17. Evaluate the relevance of workshop topics and student feedback etc. 1-5
18. How do you assess effectiveness of ASU communication and networking? 1-5
19. How engaging are the stakeholder meetings organized by CAS /ASU? High, Medium, Low
20. Relevance and appropriateness of virtual and face to face workshops (1-5)
21. What were the criteria for selection of students for the studies under this project?
22. How well have gender considerations been incorporated into ASU support extended to the partner universities (degree, exchange)? 1-5
23. Chances for graduates to find a job improved on the basis of this degree (highly, relatively, not really)
24. Were there any other research projects that you may have liked to conduct instead of what you did?
25. How do you measure an overall impact of this support? What are your indicators?
26. What are the main external factors that affected the realization or non-realization of the intended support?
27. Which support area was most effective in your opinion, prioritize from: <i>Governance, Curriculum Development, Research and Knowledge Exchange</i> ? (Lowest 1- Highest 5)
28. What were the main strengths and main weaknesses of the overall support?
Timeliness of support
29. Did the procurement processes followed slowed down timely provision of lab equipment /services (Highly, relatively, not really)
30. Were the project activities delivered in timely manner? (Highly, relatively, not really)
31. Were there any delays that required accommodating last-minute needs / changes? (Highly, relatively, not really)
32. What flexibility did ASU and the University offer to respond to last minute needs / changes? (Highly, relatively, not really)
33. How did ASU steer adaptive planning and emerging needs of the partners? Examples
34. Did the M&E provided effective feedback regarding timely implementation of the project activities? (Highly, Medium, Low)
35. Assess the timeliness of information communicated (Highly, Medium, Low)
Efficiency & Resource Utilisation
36. How did ASU catalyze information-sharing and exchange between partners and stakeholders? (1-5)
37. Which support area was provided in the most efficient manner in your opinion, prioritize from: <i>Governance, Curriculum Development, Research, and Knowledge Exchange</i> ? (Lowest 1 - Highest 5)
38. How effective did you find communication and information flow from ASU? (Highly, relatively, not really)
39. How engaging did you find ASU process (highly engaging – engaging to some extent – top down)
Sustainability of the Centers including any ASU support
40. Will this support contribute to the medium/long term sustainability of Centers' activities using evidences under the following? <ol style="list-style-type: none"> The Center notified as a statutory teaching institution of the University (Yes / No) Teaching course have been approved by the relevant University bodies / HEC (Yes / No) Faculty recruitment has been completed and are integral part of University (Yes / No) Self-sufficiency of CAS in funds for future continuation with evidence (Yes / No)

<ul style="list-style-type: none"> i. Commitment by the university to the CAS as integral part of university (Yes / No) ii. Fund raising from corporate sector (Yes / No) iii. Self-generation of funds / fund raising through own marketing (e.g. training)
41. Identify wider organizational learning taking stock of strengths, weaknesses and mistakes
42. What are the key sustainability challenges at each CAS in partner universities
Closing
43. Suggestions for optimum support from ASU during the remaining period?
44. What important lessons have we learnt that may be carried forward to future interventions?

b. External stakeholders

This checklist will be used for Key Informant interviews and Focus Group Discussions with PMU staff and faculties at UET Peshawar and NUST. The interviewers will start by introducing themselves and explaining the objective of the study. It will be a learning exercise to improve future operational performance/ support by the donors. This checklist of questions is meant to provide a guideline for the interviews and will be tailored to the knowledge/expertise/position of the respondent by **selecting questions relevant to the person/people being interviewed**. It is not necessary to ask every question to everyone. Looking at the nature of study, it is more appropriate to follow a **qualitative approach**. Therefore, this checklist is mainly based on questions meant for qualitative data collection. In addition, few questions in the checklist will also help in collecting quantitative data, where necessary.

RESPONDENT'S NAME:

RESPONDENT'S TITLE & FUNCTION:

INTERVIEWER'S NAME(S):

DATE:

LOCATION:

Questions
Opening / warm up
1. What support was extended by ASU in all five areas stipulated under the US-PCASE
Appropriateness/relevance of the ASU support
2. To what extent are the support activities in line with national demands and government initiatives in energy sector? (Highly, Average, Not Really)
4. To what extent were the University administration involved in the process? (Highly, Average, Not Really)
5. What is the relevance of courses at the CAS for Degree in Energy? (1-5)
6. To what extent this support was relevant to University / HEC / Industry priorities? (Highly, Average, Not Really)
7. Was the support relevant to the objectives of producing skilled graduates as well as promoting applied research needed to advance the energy sector in Pakistan.
8. Is this support relevant for meeting needs for Applied research? (Highly, Average, Not Really)
9. Ranking by perceived success in implementation of support from ASU: <u>Governance</u> , <u>Curriculum Development</u> , <u>Research and Knowledge Exchange</u> ? (1-5 scale)
10. What priority needs do you think the ASU support is not addressing?
Effectiveness/quality

11. How do you evaluate the overall adequacy and appropriateness of support extended? (Highly, Medium, Low)
12. How do you assess effectiveness of ASU communication and networking? 1-5
13. How engaging are the stakeholder meetings organized by CAS /ASU? High, Medium, Low
14. What are the main external factors that affected the realization or non-realization of the intended support?
15. Which support area was most effective in your opinion, prioritize from: <i>Governance, Curriculum Development, Research and Knowledge Exchange</i> ? (Lowest 1- Highest 5)
16. How do you measure an overall impact of this support? What are your indicators?
17. Chances for graduates to find a job improved on the basis of this degree (highly, relatively, not really)
18. What were the main strengths and main weaknesses of the overall support?
Sustainability of the Centers including any ASU support
19. Identify wider organizational learning taking stock of strengths, weaknesses and mistakes
20. What are the key sustainability challenges at each CAS in partner universities
Closing
21. Suggestions for optimum support from ASU during the remaining period?
22. What important lessons have we learnt that may be carried forward to future interventions?

c. Feedback by students at CAS UET / CAS NUST

Mini workshop

Name _____ Ph: _____

Date of enrolment at the center _____ Degree _____

Date of participation in exchange program _____

Name of the course attended at ASU _____

Individual questionnaire

1. Is the degree you are receiving relevant to market demands?
2. Evaluate the relevance of courses offered at ASU for completion of your degree (1-5)
3. Evaluate relevance of courses offered at the center for completion of your degree (1-5)
4. Evaluate the adequacy and appropriateness of support extended (1- 5)
5. Assess the level of support extended during preparation for the exchange program (1 -5)
6. Asses the level of support extended during the exchange program at ASU (1 – 5)
7. Criteria for selection of students for exchange program?
8. Flexibility of ASU in accommodating students as per requirements of the assignment at ASU (1-5)
9. Evaluate the timeliness of support provided (1-5)
10. Evaluate quality of teaching at the center compared to your previous studies (lower, same, higher)
11. Evaluate appropriateness and adequacy of workshops organized at thecenter (1-5)
12. Evaluate appropriateness and adequacy of virtual workshops/lectures by ASU (1-5)
13. Assess networking and communication to further your studies (1-5)
14. How well have gender considerations been incorporated while selecting students for admissions (1-5)?
15. How well have gender considerations been incorporated while selecting students for exchange program(1-5)?

16. Evaluate improvement in your chances to find a job on the basis of degree you will receive (1-5).
If above 3, why?
17. Evaluate improvement in your chances of finding a job due to the exchange program (1-5).
If above 3, why?

Plenary discussion:

18. Is this support activities in line with Govt. priorities known to you?
19. Main Strengths and weaknesses of the project?
20. Lesson learnt for future interventions?
21. Any other question to further qualify / clarify individual questions

7. Reports and information products

Publication title	Publication date	Document type
Energizer Newsletter Spring 2016	Feb. 2016	Newsletter
Energizer Newsletter Fall 2016	Oct. 2016	Newsletter
Energizer Newsletter Winter 2016	Dec. 2016	Newsletter
Energizer Newsletter Spring 2017	March 2017	Newsletter
Energizer Newsletter Summer 2017	July 2017	Newsletter
Energizer Newsletter Fall 2017	Oct. 2017	Newsletter
Energizer Newsletter FY18 Q1	Jan. 2018	Newsletter
USPCAS-E The Power of Exchange	April 2018	Flier/Brochure
Energizer Newsletter FY18 Q2	May 2018	Newsletter
Industry Engagement flier	May 2018	Flier/Brochure
USPCAS-E-K-12-outreach-brochure	May 2018	Flier/Brochure
Energizer Newsletter FY18 Q3	Aug 2018	Newsletter
Energizer Newsletter FY18 Q4	Oct 2018	Newsletter
Energizer Newsletter FY19 Q1	Jan 2019	Newsletter
USPCAS-E Overview brochure	March 2019	Flier/Brochure
Energizer Newsletter FY19 Q2	April 2019	Newsletter
USPCAS-E Fact Sheet	May 2019	Flier/Brochure
Energizer Newsletter FY19 Q3	July 2019	Newsletter
Energizer Newsletter FY19 Q4	Oct. 2019	Newsletter

Video name	Date
ASU Corporate Engagement Training Highlights.mp4	April 2018
ASU Energy Materials Workshop Highlights.mp4	Feb. 2018
ASU Energy Poverty Workshop Highlights.mp4	July 2018
ASU Energy Poverty Workshop.mp4	July 2018
ASU Hydropower Workshop Highlights.mp4	Sept. 2019
ASU Hydropower Workshop_Day 1 Sep 24.mp4	Sept. 2019

Video name	Date
ASU Leadership Training Day 1.mp4	March 2019
ASU Leadership Training Day 2.mp4	March 2019
ASU Leadership Training Day 3 - UET Peshawar.mp4	March 2019
ASU Leadership Training Day 4 - NUST.mp4	March 2019
ASU Pedagogy Workshop 1 Highlights.mp4	Jan. 2019
ASU Proposal Writing Training Highlights.mp4	Feb. 2018
ASU USPCAS-E Leadership Training highlights March 2019.mp4	March 2019
ASU USPCAS-E Solar PV Training highlights July 2019.mp4	July 2019
Corporate Engagement Training Day 1 -Apr 19 2018.mp4	April 2018
Corporate Engagement Training Day 2 -Apr 20 2018.mp4	April 2018
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Intro (energyworkshop2016_1).mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 1 Part 1(2 635536409).mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 1 Part 2(3 635544971).mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 2 Part 1(4 635505980).mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 2 Part 2.mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 2 Part 3.mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 3 Part 1.mp4	Fall 2016
Dr. Miller's Fall 2016 Energy Policy and Leadership Workshop_ The Importance of Energy Leadership - Day 3 Part 1.mp4	Fall 2016
Ehsan's advice for future exchange students-HD.mp4	Spring 2016
Energy Materials Workshop Day_1-2.mp4	Feb. 2018
Energy Materials Workshop Day_3.mp4	Feb. 2018
Fall 2016 Cohort Arrives in the U.S..mp4	Sept. 2016
Fall 2016 Lantern Festival.mp4	Fall 2016
Professor Clark Miller Talk on Energy Consumption.mp4	unknown
Professor Govindasamy talks about his experience with the first batch of exchange students-HD.mp4	2017
Proposal Writing Training Day 1 Feb 6 2018.mp4	Feb. 2018

Video name	Date
Proposal Writing Training Day 2 Feb 7 2018.mp4	Feb. 2018
Proposal Writing Training Day 3 Feb 8 2018.mp4	Feb. 2018
Technology Entrepreneurship Workshop Day_1 Sep 27 2017.mp4	Sept. 2017
Technology Entrepreneurship Workshop Day_2 Sep 28 2017.mp4	Sept. 2017
Technology Entrepreneurship Workshop Day_3 Sep 29 2017.mp4	Sept. 2017
USPCAS-E Applied Research - Providing Smart Energy Solutions.mp4	April 2019
USPCAS-E Exchange Scholar - Asfandyar Khalid.mp4	July 2019
USPCAS-E Exchange Scholar - Maham Mujahid.mp4	July 2019
USPCAS-E Exchange Scholar - Muneeza Ahmed.mp4	July 2019
USPCAS-E Exchange Scholar - Nayyera Farooq.mp4	July 2019
USPCAS-E Exchange Scholar - Shazmina Jamil.mp4	July 2019
USPCAS-E Exchange Scholars_ Spring 2019.mp4	May 2019
USPCAS-E exchange students celebrate Basant festival @ ASU-HD.mp4	Spring 2016
USPCAS-E Pedagogy Workshop_ Day 1.mp4	Jan. 2019
USPCAS-E Pedagogy Workshop_ Day 2.mp4	Jan. 2019
USPCAS-E Pedagogy Workshop_ Day 3.mp4	Jan. 2019
USPCAS-E Research - Conserving Energy Resources.mp4	July 2019
USPCAS-E Spreading the Light - Empowering Off-grid Communities.mp4	March 2019
USPCAS-E Spring 2019 exchange scholars farewell reception at Arizona State University.mp4	May 2019
USPCASE - Energizing Pakistan.mp4	
USPCASE - NUST Documentary.mp4	Aug. 2018
USPCASE - UET Documentary.mp4	Aug. 2018
USPCASE ASU Research Expo Highlights.mp4	April 2018
USPCASE at ASU Explainer Video.mp4	May 2019
USPCASE at ASU Open Door 2018.mp4	Feb. 2018
USPCASE Entrepreneurship Class Presentations (April 2018).mp4	April 2018
USPCASE Gender Workshop Part 1.mp4	March 2017
USPCASE Gender Workshop Part 2.mp4	March 2017
USPCASE Gender Workshop Part 3.mp4	March 2017
USPCASE Research Expo 2018.mp4	April 2018

Video name	Date
USPCASE_ ASU Research Experience.mp4	April 2018
Warda Mushtaq a Pakistani USPCAS-E exchange student-HD.mp4	2016

Title	Type
Quarterly Progress Reports	
QPR 2 FY15 (Jan. – March 2015)	Quarterly Progress Report
QPR 3 FY15 (April – June 2015)	Quarterly Progress Report
QPR 4 FY15 (July – Sept. 2015)	Quarterly Progress Report
QPR 1 FY16 (Oct. – Dec. 2015)	Quarterly Progress Report
QPR 2 FY16 (Jan. – March 2016)	Quarterly Progress Report
QPR 3 FY16 (April – June 2016)	Quarterly Progress Report
QPR 4 FY16 (July – Sept., 2016)	Quarterly Progress Report
QPR 1 FY17 (Oct. – Dec. 2016)	Quarterly Progress Report
QPR 2 FY17 (Jan. – March 2017)	Quarterly Progress Report
QPR 3 FY17 (April – June 2017)	Quarterly Progress Report
QPR 4 FY17 (July – Sept., 2017)	Quarterly Progress Report
QPR 1 FY18 (Oct. – Dec. 2017)	Quarterly Progress Report
QPR 2 FY18 (Jan. – March 2018)	Quarterly Progress Report
QPR 3 FY18 (April – June 2018)	Quarterly Progress Report
QPR 4 FY18 (July – Sept., 2018)	Quarterly Progress Report
QPR 1 FY19 (Oct. - Dec. 2018)	Quarterly Progress Report
QPR 2 FY19 (Jan. – March 2019)	Quarterly Progress Report
QPR 3 FY19 (April – June 2019)	Quarterly Progress Report
QPR 4 FY19 (July – Sept. 2019)	Quarterly Progress Report
Annual Progress Reports	
USPCAS-E ASU Annual Report FY16	Annual Progress Report
USPCAS-E ASU Annual Report FY17	Annual Progress Report
USPCAS-E ASU Annual Report FY18	Annual Progress Report
USPCAS-E ASU Annual Report FY19	Annual Progress Report

Title	Type
ASU study	
ASU Stakeholder Evaluation Study Report 2019	Study
Technical and Thematic workshop reports	
Green Building Workshop Report	Workshop Report
Gender Equality workshop report	Workshop Report
PV workshop Narrative Report	Workshop Report
Strategic proposal writing workshop narrative report	Workshop Report
Energy Material workshop narrative report	Workshop Report
Hydro workshop narrative report	Workshop Report
Technology Entrepreneurship workshop narrative report	Workshop Report
Leadership training report	Workshop Report
Technology Center training report	Workshop Report
Exchange visitors exist survey reports	
Exchange Students/Faculty Feedback Spring 2019	Survey report
Exchange Students/Faculty Feedback Fall 2018	Survey report
Exchange Students/Faculty Feedback Spring 2018	Survey report
Exchange Students/Faculty Feedback Fall 2017	Survey report
Exchange Students/Faculty Feedback Spring 2017	Survey report
Stakeholder Meeting Report	
3rd stakeholder meeting report	Meeting report
4th stakeholder meeting report	Meeting report
5th stakeholder and Think Tank session Report	Meeting report
6th stakeholder and Think Tank session Report	Meeting report
Final Report	

8. Project and evaluation tools

Project and evaluation tools	
1	Workshop/Training Agenda Template
2	Participant Registration/Information Form
3	Workshop/Training Narrative Report Template
4	Guidelines for Self-Assessment
5	NUST/ASU/UET Faculty Interaction Form
6	Team Bi-Monthly Narrative Report Template
7	Excursion/Event Overview Form
8	Exchange Program Evaluation – Faculty Questionnaire
9	Exchange Program Evaluation – Student Questionnaire
10	Stakeholder Feedback Form – Curriculum
11	Stakeholder Feedback Form – Sustainability
12	Stakeholder Feedback Form – USPCAS-E Research Areas
13	Participant's Feedback Form – Overall: Stakeholders Meeting
14	Joint Research Bi-Annual Progress Review Form
15	Joint Research Project Close-Out Template

9. Fundraising report

Funding sources for NUST			
Sources of funding	Type of funding	Amount received (USD)	Remarks
Askari Cement	Corporate	\$16,000	R&D Equipment & In-kinds (Donation) (Price is on Market Value)
World Bank	Competitive Bidding	\$100,000	Metrological High Precision research equipment (Donation) Market Value
UNIDO	Competitive Bidding	\$266,000	Capacity Building & Strengthening Project funded by UNIDO
HEC	Govt.	\$141,800	Development of Environmentally tolerant materials and coating for gas turbines for electrical power generation and Vehicular propulsion.
Full Advantage Co. Thailand World Bank ESMAP stream	Corporate	\$256,200	Renewable Energy Resource Mapping. Biomass (Phase 1-3) Pakistan.
Fauji Fertilizers Company Ltd.	Corporate	\$10,000	Applied research project. MoU Signed. Cost Share
HEC	Govt.	\$150,000	Towards emerging perovskite and solid state dye-sensitized solar cells
SkyElectric	Corporate	\$25,000	Installation and commissioning of 10.4 KW SMART Solar PV System.
National Natural Science Foundation of China (NSFC) and the Pakistan Science Foundation (PSF)	Govt.	\$50,000	Research on Solar Cooling, Cogeneration and Power Supply System Based on Vacuum Flat Plate PV/T Collecting and ORC Thermal Cycle
Demonstration of technical feasibility, cluster development and commercial viability of modern biomass energy conversion technologies in Pakistan	UNIDO	\$80,000	Consultancy services to UNIDO

Funding sources for NUST

Sources of funding	Type of funding	Amount received (USD)	Remarks
Retrofitting of Brick Kilns to improve Energy Efficiency and Environmental Impact	HEC-TDF	\$56,000	
Development of Accelerated Weathering Standard for Pakistan	HEC-SRGP	\$2,968	
Methane Enhancement by pretreatment of rice husk co-digested with cow manure	HEC-SRGP	\$2,968	
Non contact predictive fault analysis method for a utility transformer at DESCOS	HEC-SRGP	\$3,019	Applied research on development of a predictive fault analysis method
Multi-micro-grid (MMG) setup for modification and performance evaluation under smart grid paradigm	HEC-SRGP	\$4,800	
Total		\$1,164,755	

Funding sources for UET

Sources of funding	Type of funding	Amount received (USD)	Remarks
Directorate of science and technology (DOST)	Govt.	\$137,000	Equipment
Directorate of science and technology (DOST)	Govt.	\$125,000	Research
Pakistan aeronautical complex	Govt.	\$50,000	
Technology Development Fund	Govt.	\$80,000	
HEC Research Grant – 9,500 USD	Govt.	\$9,500	Research
Pakistan Council of Renewable energy technology	Govt.	\$10,000	
HEC – PV Lab (Dr. Najeeb)	Govt.	\$400,000	
HEC – NRPV (Dr. Saim)		\$111,580	
Predictive maintenance research project		\$135,000	
Total		\$1,058,080	

10. Recommendations for future projects

GOVERNANCE/LEADERSHIP

1. Select and appoint project directors that have the required skills and experience to fully execute the project agreement. Seek comprehensive feedback and input on terms of reference from other projects and USAID staff.
2. Create a unified cooperative agreement for all partners that can be reviewed jointly with USAID at or before the project kickoff.
3. Security concerns should be taken into consideration while designing the project, selecting implementation partners and developing work plans.
4. The development of the strategic plan and road map, as well as leadership planning and training, should be conducted within the first few months of the project's start.
5. New centers should be integrated with other schools at their host university to leverage existing resources and strengths and ensure buy-in and sustainability.

CURRICULUM

1. Conduct a comprehensive survey and assessment of workforce needs before or at the start of the project.
2. At the agreement stage, ensure that any gender equality plan is realistic and reflects a reasonable stretch goal to improve existing participation over time with milestones, regular review and course corrections.
3. To launch degree programs quickly, leverage existing curriculum as a basis for new programs.
4. Create mandatory pedagogy training in the first year of the project with yearly reviews and additional training opportunities throughout the project.
5. Create labs that serve a dual purpose: teaching and research. Partners should create lab utilization plans before procuring equipment so that labs can efficiently support both curriculum and research.

RESEARCH

1. Set expectations for research publications and presentations and quantify with metrics; review metrics regularly. Provide professional development opportunities for faculty on writing grant proposals and journal articles.
2. Facilitate and support research presentations at academic and industry conferences.
3. Host local research expos to showcase research done by faculty and students.
4. Host workshops in-country. Work with partner institutions to ensure a near 100 percent participation rate by faculty and students.
5. Create an efficient procurement process that empowers faculty.
6. Create research evaluation forums that include relevant technical experts and create a communication mechanism that ensures continuity, and that brings new reviewers up to speed as needed.

EXCHANGE

1. The ASU exchange program was a transformational experience based on the feedback received from participating faculty and students. A U.S. exchange program should be considered as a part of every donor-funded project in the area of higher education.
2. Create an inclusion plan for women and economically disadvantaged students that factors current local participation rates and identifies incremental improvements that address cultural and economic barriers and enhance academic preparation in secondary schools.

SUSTAINABILITY

1. At the project start, create an action plan for strategic development, fund raising and industry interaction that includes milestones and deliverables. Update the plan at least annually.
2. Make sustainability a cross-cutting component or, more specifically, a mindset rather than a separate goal. In the USPCAS-E project, each component had sustainability goals. Creating a sustainability mindset ensures that all component-specific efforts align with the overall strategic direction of the centers.
3. Identify key stakeholders and engage them regularly throughout the project. Create a stakeholders forum which meets biannually or quarterly.
4. Create something like the National Energy Research Agenda (see Annex 5) at the beginning of the project as part of the strategic planning process.





11. Financial report

FINANCIAL ANALYSIS OF PROGRAMMATIC RESULTS

▼ The table below is the summary of the overall project funds, expenditures, and allocations.

	Obligated budget	Expended I.t.d	Unobligated	% of budget committed
Total direct cost	\$14,602,344	\$14,135,359.89	\$466,984.11	97%
F&A – 26.00%	\$2,593,561	\$2,474,027.25	\$119,533.75	95%
Total expenditures	\$17,195,905	\$16,609,387.14	\$586,517.86	97%

BUDGET TO ACTUALS FINANCIAL REPORT

USAID USPCAS-E Cooperative Agreement AID-391-A-15-00001

▼ Activity through project close

Budget category	Obligated budget	Expended I.T.D.	Unobligated	% of budget committed
Personnel expenditures				
ASU salaries & wages	\$4,223,283	\$4,199,073.33	\$24,209.67	99%
ASU ERE	\$ 1,275,742	\$1,356,611.18	-\$80,869.18	106%
Subtotal ASU personnel expenditures	\$ 5,499,025	\$5,555,684.51	-\$56,659.51	101%
Pakistan personnel expenditures	\$ 2,101,582	\$2,070,970.23	\$30,611.77	99%
Total personnel expenditures	\$7,600,607	\$7,626,654.74	-\$26,047.74	100%
Operations expenditures				
Domestic Travel	\$ 67,769	\$60,593.66	\$7,175.34	89%
International Travel	\$ 672,480	\$507,169.68	\$165,310.32	75%
Overseas Allowances	\$ 97,370	\$46,557.87	\$50,812.13	48%
Materials & Supplies	\$ 340,434	\$287,824.89	\$52,609.11	85%
Subaward - OSU	\$ 729,103	\$605,690.47	\$123,412.53	83%
Subaward - IUCN	\$ 1,219,480	\$1,103,271.23	\$116,208.77	90%

Budget category	Obligated budget	Expended I.T.D.	Unobligated	% of budget committed
Consultant: Louis Farina	\$ 87,536	\$40,595.40	\$46,940.60	46%
Consultant: Giant Angstrom	\$ 23,086	\$18,270.35	\$4,815.65	79%
Consultant: other	\$ 50,000	\$6159.33	\$43,840.67	12%
Training & conferences				
Launch event	\$ 11,699	\$11,698.68	\$0.32	100%
Exchange visits	\$ 1,572,006	\$1,926,096.56	-\$354,090.56	123%
Other workshop/ conference	\$ 80,000	\$20,279.01	\$59,720.99	25%
Research grants	\$ 659,444	\$690,113.97	-\$30,669.97	105%
Communications & branding	\$ 369,502	\$172,723.84	\$196,778.16	47%
Other direct costs	\$ 1,021,826	\$1,011,660.21	\$10,165.79	99%
Total operation expenditures	\$7,001,737	\$6,508,705.15	\$493,031.85	93%
Total direct costs	\$14,602,344	\$14,135,359.89	\$466,984.11	97%
F&A - 26.00%	\$ 2,593,561	\$2,474,027.25	\$119,533.75	95%
Total expenditures	\$17,195,905	\$16,609,387.14	\$586,517.86	97%

The funds were used supporting the staff and faculty in the US and Pakistan, exchange program at ASU and OSU, curriculum development, joint research projects, workshops, training, stakeholder meetings, sustainability activities and other activities . The overall results from these activities are as follows:

GOVERNANCE

- Developed governance structures that facilitate an ongoing dialogue about energy education and research needs in Pakistan. We held 10 stakeholder and Think Tank meetings engaged nearly 500 representatives from Pakistan's energy sector, including academia, government, NGOs and industry.

CURRICULUM

- Jointly developed curriculum with NUST and UET resulting in over 13 modern degree programs and 1 51 industry-relevant courses.
- Developed more than 16 labs in various energy areas.
- Supported the hiring of 45 new faculty members.
- Both centers has enrolled more than 1,000 master's and Ph.D. students in energy graduate programs.
- Both centers graduated more than 300 students from the centers at NUST and UET Peshawar with advanced degrees in energy — with many more students in the pipeline.
- Recruited and supported women and disadvantaged students in energy engineering programs.

RESEARCH

- Conducted 12 joint research projects with U.S. and Pakistani principal investigators.
- Conducted 36 applied research projects.
- Created 16 state-of-the-art labs and two libraries.

EXCHANGE AND SCHOLARSHIPS

- Hosted 217 students and faculty for a semester-long exchange experience at ASU and OSU in the U.S., where scholars were embedded in a sophisticated research university using the latest equipment, techniques and protocols in energy policy, photovoltaic reliability, power systems, energy materials, fuel cells and batteries and thermal energy. Visiting scholars also received entrepreneurial and energy policy training.
- Offered in-country training provided by industry experts on a wide variety of technical topics. More than 30 hands-on workshops and seminars related to various energy sectors were offered.
- 555 scholarships awarded.

SUSTAINABILITY

- Secured over 121 internships for USPCAS-E students.
- Raised more than \$2 million from public and private entities.
- Conducted more than 70 meetings with public and private energy sector partners in Pakistan.
- Developed the framework and extensive training for Technology Centers at each center; these centers will offer critical testing services and training opportunities in photovoltaics.

WORKSHOPS & TRAINING

Workshop delivered in Pakistan		Presenter	Year
1	Renewable Energy, PV System	Dr. Sayfe Kiaei	2015
2	Energy Policy and Leadership	Dr. Clark Miller	2016
3	Batteries and Fuel Cells	Dr. Arunachala Mada Kannan	2016
4	Green Buildings	Dr. Harvey Bryan	2016
5	Gender	Dr. Chad Haines	2017
6	PV Certification and Reliability	Dr. Govindasamy Tamizhmani	2017
7	Technology Entrepreneurship	Mr. Kenneth Mulligan	2017
8	Strategic Proposal Development Workshop	Mr. Alan Paul	2018
9	Energy Materials: Research Opportunities in Photovoltaics	Dr. Zachary Holman	2018
10	Corporate Engagement	Mr. Lou Farina	2018
11	Hydro Power	Dr. Kendra Sharp	2018
12	Leadership Training	Dr. Dan Shunk	2019
13	Pedagogy Training	Dr. Peter Rillero	2019
14	Technology Center Training	Mr. Bulent Bicer	2019

Seminar delivered in Pakistan		Presenter	Year
1	Multi-disciplinary research work: Freedom Project	Dr. George Karady	Nov. 2016
2	Hydrogen Economy: Problems and Prospects	Dr. Arunachala Mada Kannan	Feb. 2017
3	Recent Advances in High Temperature Solar Thermal Power Generation	Dr. Brian Fronk	May 2017
4	Where will solar go next?	Dr. Zachary Holman	Sept. 2017
5	Solar Photovoltaics – Testing and Certification	Dr. Govindasamy Tamizhmani	Dec. 2017
6	The Social Drivers, Dynamics, and Outcomes of Energy Innovation	Dr. Clark Miller	March 2018
7	Technical Issues in Thermal Power Generation, and How You Can Solve Them	Dr. T. W. Lee	Sept. 2018
8	Entrepreneurial Mindset	Mr. Kenneth Mulligan	Dec. 2018
9	Use of Hydropower Assessment Tool (HPAT) for Small Hydro	Dr. Kendra Sharp	April 2019

TRAININGS AT ASU

Online course delivery training

ASU assisted the center staff in getting up to speed in online course delivery for graduate courses by:

1. Identifying the appropriate learning management system (LMS) to deliver courses
2. Identifying IT requirements for the LMS
3. Identifying best practices for online course delivery at the faculty level

In June 2019, ASU organized a training program in online course delivery for faculty and staff from NUST and UET Peshawar.

	Obligated Budget	Expended I.T.D	Unobligated	% of Budget Committed
Launch event	\$ 11,699	\$11,698.68	\$0.32	100%
Exchange visits	\$ 1,572,006	\$1,926,096.56	-\$354,090.56	123%
Other workshops/ conferences	\$ 80,000	\$20,279.01	\$59,720.99	25%

BUDGET CATEGORIES IN COOPERATIVE AGREEMENT

Labor and fringe – faculty/staff salaries

The center supported staff in Pakistan including deputy directors at NUST and UET, Technical Advisors at NUST and UET, M&E operation, communication and marketing, sustainability, and admin support. At ASU, the center supported the center director, operations director, project manager, communication and marketing director, finance, HR, and administrative support. The center also supported the faculty and graduate students working with the exchange program, workshops, curriculum and research projects.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
ASU salaries & wages	\$4,223,283	\$4,199,073.33	\$24,209.67	99%
ASU ERE	\$1,275,742	\$1,356,611.18	\$-80,869.18	106%
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Pakistan personnel expenditures	\$2,101,582	\$2,070,970.23	\$30,611.77	99%
Total personnel expenditures	\$7,600,607	\$7,626,654.74	\$26,047.74	100%

Travel and transportation

All travels to Pakistan and within U.S. This covered travel by the director, project manager, and other staff visiting Pakistan, security operations, travel within the U.S. to OSU and related travels, and Pakistan-based USPCAS-E staff travel to the U.S.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Domestic travel	\$ 67,769	\$60,593.66	\$7,175.34	89%
International travel	\$ 672,480	\$507,169.68	\$165,310.32	75%
Overseas allowances	\$97,370	\$46,557.87	\$50,812.13	48%

Equipment and supplies – purchased in U.S., Pakistan

The materials purchased in Pakistan were included in invoices from IUCN which is under the subaward section.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Materials & supplies	\$340,434	\$287,824.89	\$52,609.11	85%

Subawards/contractual

The subawards were given to IUCN for supporting the center, workshop costs in Pakistan, and materials purchased in the U.S. The OSU subaward covered the travel costs, faculty and staff salaries for the exchange and joint research projects.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Subaward – OSU	\$ 729,103	\$605,690.47	\$123,412.53	83%
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Consultant: Giant Angstrom	\$ 23,086	\$18,270.35	\$4,815.65	79%
Consultant: other	\$ 50,000	\$6159.33	\$43,840.67	12%

Research costs – joint research projects

Twelve joint research projects with conducted with U.S. and Pakistani principal investigators. The goal of these projects was to strengthen the research culture facilitate fruitful interactions with industry, government agencies and international colleagues.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Research grants	\$659,444	\$690,113.97	\$-30,669.97	105%

Branding and publications – PR, communication, marketing

Communication expenditures included support for all meetings, events and workshops in Pakistan that included signage, informational handouts, photography and video resources, and staffing. Also included in this category were printing of reports and other informational pieces, key mailings to stakeholders to keep the project top-of-mind, and email and video distribution services. Communications expenditures also included writing and graphic design support for all required quarterly and annual reporting to USAID, periodic promotional content and outreach to stakeholders.

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Communications & branding	\$369,502	\$172,723.84	\$196,778.16	47%

Other direct costs

	Obligated budget	Expended I.T.D	Unobligated	% of budget committed
Other direct costs	\$1,021,826	\$1,011,660.21	\$10,165.79	99%

