

# **John and Willie Leone Family Department of Energy and Mineral Engineering**

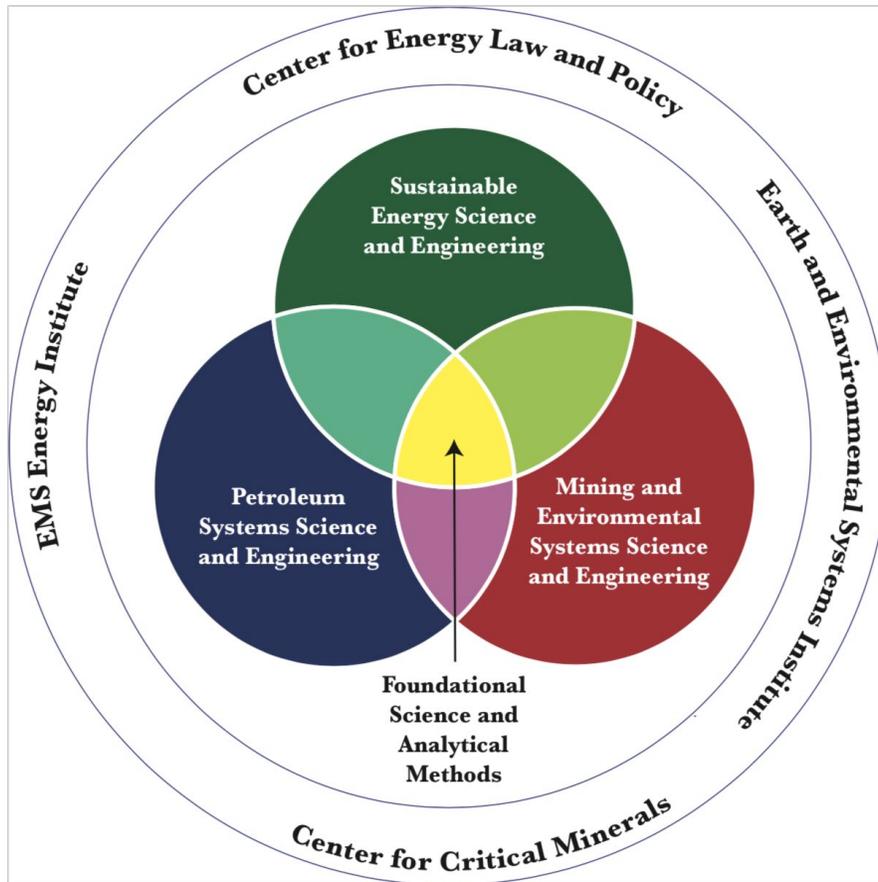
## **Strategic Plan for the Period 2020-2024**

**Vision:** The John and Willie Leone Department of Energy and Mineral Engineering will be a global leader in the advancement of research and education in energy systems and use of earth's resources in sustainable, secure and ethical ways by integrating science, technology, policy and business.

**Mission:** EME is a unique department at Penn state with an integrative focus on energy and earth resources. The diversity of expertise in the department and value placed on interdisciplinary scholarship enables EME to play a special role in integration across traditionally disparate fields to address major technological and social challenges related to sustainable energy and the use of earth's resources. We conduct innovative, forward-looking research across the life cycle of energy systems, technologies, economics and policy. We train future energy and natural resource professionals through innovative and accessible educational practices grounded in real-world problems. Our faculty, researchers, and students value engagement with the public and private sectors to improve science-based decision-making.

### **Introduction**

With this strategic plan, we lay out concrete steps towards major transformation and realignment of the John and Willie Leone Department of Energy and Mineral Engineering to better equip the department and Penn State to address the complex challenges facing society in managing the energy and mineral resources in an efficient, sustainable, and resilient manner. The world is in the midst of transformation, disruption, and uncertainty in all aspects of energy and mineral resources. This includes new technologies, industrial and business models, regulatory goals and approaches at many levels of governance, and unprecedented stressors and shocks on these systems. EME is in a unique position to address these challenges by building on our historical strength across multiple disciplines and domains that are rarely co-located in the same department, including the long proud history of leadership in petroleum and natural gas engineering, mining engineering, fuel sciences, and energy and mineral economics. At the same time, we recognize that the challenges of the coming decades and research and educational programs to address them call for something more than the aggregation of these traditional fields. It is also important to recognize that the basic objective of most students, initially, is to receive a high-quality education that allows them to secure gainful employment with one of Penn State's stakeholders. The next step in EME's evolution will neither abandon our existing discipline, domain excellence and methodological expertise in traditional resources and infrastructures, nor will we be limited to them. We will continue to strive to incorporate our excellence and expertise in to our educational offerings and prepare students for the many challenges ahead.



**Figure 1: EME’s interdisciplinary pillars will define the department’s vision for research and education for the next generation of the department’s faculty and students.**

In this document, we lay out a vision of EME as a department that will be built around three interdisciplinary domain pillars in the coming decades, as shown in Figure 1. We will focus on further developing our strength in **sustainable energy systems science and engineering**, recognizing that society’s use of energy resources is entering a major transition period that will see our current and future graduates experiencing tremendous change throughout their careers. Society must make its energy use more sustainable, and EME must position its scholarship and educational efforts to be in a leadership position in decisions and design of next-generation energy systems. We will build on our decades-long legacy to be at the forefront of **petroleum systems science and engineering**, recognizing that the science of reservoir characterization, drilling and production engineering, enhanced hydrocarbon recovery and petroleum systems design can be used to increase the sustainability and efficiency of petroleum and natural gas while those energy sources continue to play major societal roles. These skills must be harnessed to effectively make energy systems more carbon-neutral through carbon capture and long-term geologic sequestration. The plan fully recognizes the important role that natural gas will play in the transition to a low carbon energy footprint especially considering the abundance of such resources in Pennsylvania. Finally, we recognize that facilitating a global energy and technology transition in an economically and environmentally sustainable way is impossible without **mining and environmental systems science and engineering**, to ensure sufficient supplies of critical materials for energy and technology applications. EME will leverage its unique capabilities to addressing the entire life cycle of mineral extraction, processing, reuse and site reclamation.

The department also commits to revising its undergraduate program curricula to recognize and emphasize **scientific foundations and analytical tools** across the basic energy, decision and risk sciences that are increasingly common and necessary across all three domains.

Our overall vision requires greater integration of activities across traditional applications and the deliberate addition of critical expertise in specific methods and processes. New processes, technologies, and infrastructures that improve the sustainability and resiliency will require novel combinations of expertise; e.g., geomechanics with data science and machine learning, electrochemistry with power system optimization, environmental engineering with mining engineering and risk analysis; catalysis for biofuels with resource harvesting from wastewater or carbon capture with energy economics. Careful restructuring of research activities, educational programs, and the physical environment of the department will be critical to promote and enable such unique collaborations and successes.

Each of the goals and sub-objectives are designed to support this overall vision. The focus of significant new research activities will target grand challenges such as sustainable and resilient energy infrastructures and improved health, safety, and environmental impacts from resource extraction and utilization. Tenure-line and research faculty hires, whether new lines or filling vacant positions, will be oriented towards building strength towards this interdisciplinary vision. Educational programs will also be more closely aligned with one another, and an expanded core of fundamental science and analytical methods will train future professionals and leaders in rigorous problem-solving skills that can be applied to whatever technologies and challenges emerge over their career. Expanded partnerships and outreach to industrial and regulatory stakeholders will ensure that EME's activities remain focused on the most important and most difficult problems and result in greater impact. Undergirding all these efforts will be major upgrading of our physical space preferably in the form of a new Hosler building, whose design will reflect the integrative and interdisciplinary vision. The cumulative effect of these efforts will be a vibrant department that is the leading center for research and education in energy and mineral resource systems for the next century.

---

*Goal # 1: Innovative and Convergent Research Leadership*

---

**Foundation:** Ensuring a Sustainable Energy and Resource Future<sup>1</sup>

**Thematic Priority:** Stewarding Our Planet's Resources, Transforming Education

**Supporting Element:** Constituent Outreach and Engagement

**Objective:** Create an innovative research environment in the department, stimulate multidisciplinary collaboration and research within the department (growing convergence research, NSF's 10 big ideas), target to become a domestic/global leading energy department in research. The emphasis is on organizing the research within the three interdisciplinary domain pillars shown in Figure 1, while making sure that we focus on areas that add strength to those three domains on an integrative basis.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:** Funding application, research expenditure, publication, conference/workshop hosting (energy society impact).

Themes in research

**Objective 1.1:** Reducing life cycle impacts on energy and mineral systems. This theme applies to each of the three domains of sustainable energy systems, petroleum systems as well as mining systems with interfacial sciences, environmental chemistry, economics and policy being the chief enablers.

- Low carbon footprint, carbon capture, utilization and storage (CCUS, DOE)
- Reduce water consumption (water security grand challenge, DOE)
- Reduce environmental/soil pollution
- Improve extraction efficiency (DOE, Industry)

Action Items:

- Develop faculty expertise and curriculum around carbon capture and sequestration
- Hire faculty/specialists working in the area of nanomaterials for energy applications for improving efficiency of processes – nanofluidics, reaction, thermodynamics, computational modeling
- Expand experimental capability to study geothermal systems

---

<sup>1</sup> "Sustainable Energy and Resource Future" mean availability of affordable, reliable, and dependable energy and mineral resources to society with low or negative contribution to air, water and soil pollution as well as low or negative contribution to greenhouse gas emissions.

- Establish state-of-the-art laboratory and modeling capability to study enhanced hydrocarbon recovery processes that minimize the environmental footprint of such processes.
- Establish mine automation minor in collaboration with mechanical engineering
- Expand laboratory mineral processing capabilities to investigate technologies reducing water consumption

**Objective 1.2:** Human centered solutions to challenges in energy and resource engineering: This also has relevance to each of the three domains with risk analysis, policy and decision making, industrial health and safety being the chief enablers.

- health and safety (NIOSH, NIH)
- ethics
- risk analysis (DOE, Industry)
- coupled systems – feedback and tradeoff (NSF, NIOSH)
- policy and decision-making (DOE, DEP-PA)

Action Items:

- Establish a general education offering on energy transitions and ethics
- Hire faculty/specialists working in the area of analysis of coupled systems
- Expand laboratory capabilities and collaborations to study human and energy systems interactions – Set up dust research lab

**Objective 1.3:** Energy infrastructure design and analysis: This has relevance to sustainable energy systems science and petroleum systems science with systems optimization, electrochemistry, data analytics and economics and policy acting as the main enablers.

- energy storage grand challenge (DOE)
- community sustainable energy (solar/wind)
- data analytics and block chain/system optimization
- Critical Materials Processing Technology (DOE)
- coupled climate/energy grid policy (DOE, Industry)
- resilience (NSF)

Action Items:

- Expand expertise in solar related research – explore collaboration with other entities such as MCOR for developing a certificate program for community solar
- Establish a field site for study novel processes for studying CO<sub>2</sub> sequestration and enhanced resource recovery.
- Hire faculty/specialists working in the area of energy policy (renewables as well as oil& gas, mining)
- Hire systems modeling faculty (optimization, feedback, coupling processes)
- Expand laboratory capabilities for electrochemistry, battery design using carbon materials, battery failure analysis

**Objective 1.4:** Modeling for sustainability, resilience and prediction of energy and mining system: Is of relevance to all the three domains with computational science, data analytics and visualization, statistical learning, stochastic modeling acting as the chief enablers.

- High performance computation, AI, deep learning, neural nets, and predictive data analytics for energy and resource modeling. Next-generation computational approaches/tools (like quantum computing) (DOE-SCIDAC, NSF-BIG DATA)
- multiscale, multiphysics, multi-domain oil & gas, renewables, mining (NSF, DOE-EFRC)
- virtual asset(s) to guide research, education, and outreach (DOE, Industry)

Action Items:

- Extend the capability of EME capstone design center – data warehousing, computer infrastructure
- Hire faculty/specialists working high performance computation – multiscale, multiphysics, hybrid AI/HPC system specialists, machine learning
- Establish visualization/ digital twinning/ high performance computation infrastructure
- Embed data analytics throughout our curriculum

---

*Goal #2: Create and implement a world-class curriculum in energy, resource development and environmental systems*

---

**Foundations:** Enhancing Global Engagement, Enabling Access to Education, Engaging Our Students

**Thematic Priorities:** Stewarding Our Planet’s Resources, Transforming Education, Empowering Through Digital Innovation

**Supporting Element:** Constituent Outreach and Engagement

**Goal Summary Name:** Energy curriculum

**Goal Description:** EME will be a model for a **resilient curriculum in energy, resource development and environmental systems** that enables students to adapt professionally as industry sectors change. Educate and train energy professionals in a way that harnesses the breadth and depth of EME’s expertise in energy and natural resources and systems and allows our expertise to reach traditional and non-traditional student audiences. Our goal is also to develop the resilient curriculum without jeopardizing our current accreditation status that allows our programs ranked among the best in the world.

**Objective Name:** 2.1 Revitalize curriculum

**Objective:** Modernize our portfolio of undergraduate and graduate curriculum with new tools and methods (e.g., Data Analytics), and towards the solution of novel problems at the human-energy nexus and execute these reforms without jeopardizing our accreditation status.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Student Rating of Teacher Effectiveness (SRTEs) from the corresponding affected courses in the action items below
- Devise specific rubrics for the targeted curricular objectives pertaining to each action item below and assess efficacy vis-a-vis quality of student work each offering (similar to, and perhaps in conjunction with, ABET curriculum assessment)

**Action Items:**

- Develop a robust and innovative offering in energy ethics (set of courses, certificate, minor).
- Tailor a Data Analytics course to energy and resource extraction-related subject matter, including energy systems, mineral resources, finance, and environmental topics.

- Mobilize existing undergraduate and graduate curriculum towards the development of ethical, sustainable, and human-centered solutions to technology challenges faced in the energy and mineral resource industries, making risk assessment and perception, ethics and policy a central part of the department's portfolio. Emphasis here is on energy-human systems interactions.
  - Develop a General Education course on energy transitions.
  - Hire systems analysis faculty/researchers/instructors.

**Objective Name: 2.2 Broaden the reach for EME's unique curriculum**

**Objective:** Deliver our curriculum to students from a wider variety of career stages and geographical areas.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Catalog of what curriculum we can make available online
- Survey online students, continuing education students, and those taking workforce training and certificate courses
- Physical count of communities and stakeholders contacted by our outreach effort
- Track feedback from alumni and industry

**Action Items:**

- Expansion of ability to reach in-person and distance audiences, principally through a major initiative to hybridize as much of our curriculum as possible while emphasizing experiential learning.
- Expand programs beyond traditional BS/MS/PhD. For example, workforce training, professional continuing education, and certification. Team up with professional societies such as AICHE, SPE, SME as well as professional organization such as IHRDC to accomplish this.
- Establish an EME outreach effort that focusses on providing offsite training to a diverse group of participants, communicates research breakthroughs to stakeholders through research showcases and workshops, collects and maintains data related to energy and environmental impacts.

**Objective Name: 2.3 Secure opportunities for our students**

**Objective:** Make our students more successful in their career goals through greater exposure to today's challenges faced by industry and researchers.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- SRTEs from the corresponding affected courses in the action items below
- Devise specific rubrics for the targeted curricular objectives in each action item below and assess efficacy vis-a-vis quality of student work each offering (similar to, and perhaps in conjunction with, ABET curriculum assessment)
- Track job placement, successes and disappointments
- On campus industry speakers
- Number of alumni/student mentoring conducted via EMS college mentoring program

**Action Items:**

- Engage industry, external research units, and community organizations in our capstone design courses.
- Extend our capstone design courses into internships outside of our department, in correlation with the item above. Develop flexibility in curriculum to accommodate externships.
- Create an interdisciplinary capstone design course that has teams of students from different majors solving a complex problem.
- Initiate a Research Experience for Undergraduate program in our department. Develop funding source (NSF, Industry, Endowment) to support this.

---

*Goal #3: Develop collaborative, research-based partnerships with external organizations*

---

**Foundations:** Enhancing Global Engagement, Ensuring a Sustainable Future

**Thematic Priorities:** Stewarding Our Planet's Resources, Transforming Education

**Supporting Elements:** Constituent Outreach and Engagement, Infrastructure and Support

**Goal Summary Name:** Develop partnerships

**Goal Description:** *EME will lead in the development of energy and earth resources focused partnerships with research and industry institutions outside of Penn State, to enhance research and promote the department's vision for a more integrated undergraduate and graduate curriculum.* EME's strong focus on energy resources and systems, as well as our interdisciplinary capabilities, put the department in a strong position to forge formal partnerships with institutions working in these areas. These partnerships can be mutually beneficial, as EME faculty and students can access research resources and additional mentorship from outside of the department; and external partners can develop a pipeline for future scientists and engineers. EME envisions focusing on developing three kinds of partnerships over the next five years, focused on collaborative research, graduate student experiences and our undergraduate capstone. While we realize that sustenance of such partnerships would require commitment from the university administration, it is also in the best interest of the department to initiate and strengthen partnerships in specific areas of interest to the department.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Objective 3.1:** EME will prioritize development of partnerships by establishing an administrative structure to achieve this goal. This will involve the selection of a faculty member (the Department Head or a designee) to lead EME's partnership efforts and chair a standing committee or task force. This committee will have responsibility for making progress on Objectives 5.2 through 5.4, which cover three kinds of partnerships that EME plans to pursue.

**Key Performance Indicators:**

- Faculty lead and staff support for partnership development identified
- Membership on three subcommittees determined - these subcommittees will focus on research partnerships, graduate student experiences, and the undergraduate capstone.

**Action items:**

- Identify and charge the faculty member who will lead the partnership committee, and ensure that this person has adequate support (staff support, teaching release, other compensation)
- Designate and charge the overall partnership committee and three subcommittees.

**Objective 3.2:** EME will organize formal research-based partnerships with external organizations such as DOE National Laboratories and industry research organizations (e.g. EPRI). Research-based partnerships are indicated by formal agreements to participate in joint research activities. These may also involve developing mechanisms for joint faculty appointments with partner institutions, and mechanisms for adjunct appointments within EME for scientists at external partner institutions.

Examples of potential partners and alignment with department strengths include, but are certainly not limited to:

- a. NETL - carbon capture, sequestration and management
- b. NREL - renewable power generation, power system optimization/modeling
- c. LANL - optimization and computational methods for energy infrastructure
- d. INL - economics and policy around nuclear power
- e. EPRI - future electricity systems

**Key Performance Indicators:**

- Number of established and in-progress partnership agreements
- Number of students and faculty engaged with research partnerships
  - Number of contributions by scientists at partner institutions towards graduate research mentorship (e.g., service on graduate thesis/dissertation committees)
  - Faculty sabbaticals or other research-based time embedded with partner institutions (these could also be in-person or virtual if needed)
- Number of students employed Total research output arising from these partnerships
  - Joint papers
  - Research funding

**Action items:**

- Form and charge a subcommittee for research partnerships.
- Identify lists of potential partners and alignment with department strengths.
- Identify potential partnership models - e.g., MOUs around specific research topics, industry-university consortia.
- Establish relevant faculty champions and contact person at each external organization.
- Organize high-level discussions with potential partners to identify strategic focus areas. This would be most beneficial if it involved delegations from Penn State to the organizations or vice versa.
- Work with the Associate Dean for Graduate Education and Research on an appropriate partnership structure.
- Work with the Associate Dean for Graduate Education and Research on models for joint appointments, involving joint faculty appointments with external institutions or adjunct appointments in EME for scientists at partner institutions.

**Objective 3.3:** EME will work with external partners to establish a mechanism to place graduate students for extended research internships with partner institutions and other traditional supporters of our programs. EME envisions these internships lasting between six months to one year, though other models are possible.

**Key Performance Indicators:**

- Number of established and in-progress partnership agreements, as measured by completed or in-progress MOUs.
- Number of students in-resident experiences at partner institutions (these could be in-person or virtual if needed)
- Number of students employed post-graduate at partner institutions
- Collaborative research or mentorship achievements:
  - Joint papers produced during internships
  - Proposals supported during internships
  - Service by internship mentors on graduate thesis/dissertation committees.

**Action items:**

- Form and charge subcommittee for graduate student internship partnerships.
- Establish a database of alumni and contact them for assistance with setting up internships.
- Identify lists of potential partners and alignment with department strengths.
- Work with the Associate Dean for Graduate Education and Research on an appropriate MOU structure.

**Objective 3.4:** EME will work with external partners and alumni groups such as the GEMS board to support the department's envisioned integrative capstone experience.

**Key Performance Indicators:**

- Number of established and in-progress capstone topic or team mentorship activities.
- Number of undergraduate students going through an integrative capstone experience in conjunction with one of EME's external partners.

**Action items:**

- Form and charge subcommittee for undergraduate capstone partnerships. **1** (all the remaining items follow sequentially)
- Identify lists of potential partners, alumni and other supporters and establish alignment with the department's integrative undergraduate education goals.
- Work with the Associate Dean for Undergraduate Education and Research on an appropriate MOU structure, if needed.

**Objective 3.5:** EME will leverage its leadership in College-wide and University-wide Centers and Institutes to showcase its research potential and move partnerships forward. Faculty with their tenure home in EME have served in leadership roles in the EMS Energy Institute and the Center for Energy Law and Policy. The

department will seek to use these affiliations as assets to demonstrate our integrative capabilities and research focus to potential partners.

**Key Performance Indicators**

- Center/Institute leadership engaged in one or more of EME’s partnership committees
- Number of partner organization visits (virtual or in-person) from Center/Institute leaders
- Number of agreements with partner organizations that focus on strategic areas represented by Centers/Institutes

**Action Items**

- Engage Center/Institute leaders in EME’s planning for partnerships.
- Include Center/Institute focus areas in partnership agreements.

---

*Goal #4: Create a more diverse and inclusive department*

---

**Foundation:** Advancing Inclusion, Equity, and Diversity

**Thematic Priority:** Transforming Education

**Supporting Element:** Constituent Outreach and Engagement

**Goal Summary Name:** Diversity and department climate

**Goal Description:** EME has the opportunity to foster a more diverse population of faculty, staff, and students while creating a welcoming and inclusive departmental culture that uses our shared commitment to excellence in energy scholarship and teaching. While our broad goal is to maintain healthy enrollment of students in all our programs, we will use our re-imagined department structure to break down barriers among communities of various identities and perspectives, backgrounds, and experiences. The objectives outlined for this goal seek to create a welcoming department climate and expand our efforts to ensure a diverse pipeline of professionals into the energy industry from our undergraduate and graduate programs.

**Objective Name:** 4.1 Diversity in Student Recruitment and Retainment

**Objective:** To recruit and attract significant number of outstanding students into our undergraduate and graduate programs. Recruit and retain female and underrepresented minority talent at the undergraduate and graduate levels.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Enrollment numbers of students in all our programs and options.
- Academic profile of students entering our programs and options
- Number of female student / URM students accepted to EME majors
- Female student/URM sentiment or pulse tracking through surveys

**Action Items:**

- Establish liaison with local area high schools through establishment of summer workshops for high school teachers
- Engage with Commonwealth campuses to develop explicit engagement opportunities for students intending undergraduate EME majors

- Engage with Commonwealth campuses to create new channels to engage female and underrepresented minority students in considering undergraduate EME majors and provide them the pathway to complete early coursework at the campuses near their homes
- Develop partnerships with historically black colleges and university to engage students to pursue graduate programs in EME
- Develop partnerships with high schools near Commonwealth campuses to create a pipeline of more diverse students entering the Penn State system intending EME undergraduate majors
  - Establish a departmental level Environmentors program
- Work with existing student groups on campus at University Park
  - Provide activities to bring together student organizations at orientation to establish a singular EME identity
- Continue to develop core curriculum across EME majors to establish department-level identity and sense of place
- Work with companies on internship programs for female and URM students
- Address major challenges in diversity and gender balance in the broader energy sector by creating a more diverse pipeline into industry and graduate study

**Objective Name: 4.2 An Inclusive Departmental Culture**

**Objective:** To create and maintain an inclusive departmental culture in which faculty, staff, and students feel respected, accepted, and safe regardless of gender identity, race or ethnic background, socioeconomic status, or other potentially polarizing indicators.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Utilize ALLWE and (forthcoming) Campus Climate 2020 Survey results to identify problem areas to target.
- Number of departmental social events and attendance at these events
- Department culture and sentiment tracking through surveys

**Action Items:**

- Create a climate and identity among faculty and students in the department that we are all passionate energy scholars regardless of the kinds of systems or technologies on which our scholarship and teaching focus. Appoint a department ombudsperson.
- Create additional opportunities for the department to come together through seminar series and other departmental level social events. Conduct a brainstorm session to revitalize the awards banquet event and make it more inclusive.

**Objective Name: 4.3 Diversity in Faculty and Staff Hiring**

**Objective:** To recruit and retain female and underrepresented minority talent across faculty and staff ranks.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Show significant increase in qualified female / URM candidates interviewed for open faculty and staff positions.

**Action Items:**

- Targeting recruitment activities specifically to minority populations
- Work with select commonwealth campuses to diversify the applicant pool for our open staff positions
- Provide adequate training on detecting and curtailing implicit bias during the recruitment process

---

*Goal #5: Champion facility upgrading as pivotal for accelerating growth in efficiency, productivity and cohesion in EME research, teaching, and outreach missions*

---

**University Strategic Plan:** Availability of upgraded state-of-the-art facilities is directly tied to every element of the university plan foundations: **Enabling Access to Education, Engaging Our Students, Advancing Inclusion Equity and Diversity, Enhancing Global Engagement, and Ensuring a Sustainable Future.** The main thematic priority is **Transforming Education, Enhancing Health, Stewarding Our Planet’s Resources,** and the supporting element is **Infrastructure and Support.**

**Goal Summary Name:** Facility Upgrading including Hosler renovation

**Goal Description:** Fulfilling the vision of EME as a global leader in integrative research and education the integration of science, technology, policy and business requires the availability of state-of-the-art facilities enabling it. EME facility upgrading (Hosler building in particular) is listed as one of the 2023-2028 capital project priorities of the University aimed at a comprehensive renovation of the building system and infrastructure. EME is positioned to enhance its unique capabilities and potential with this upcoming infrastructure renovation, which will be reflective of the integrative and interdisciplinary vision laid out in this strategic plan. New and upgraded facility design will prioritize integrative spaces that encourage cross-talk among researchers, disciplines, and internal/external stakeholders, innovative educational environments, and a model of functionality balanced with energy efficiency and conservation.

**Objective:** Integrate facility upgrading including Hosler building renovation project into our 2020-2024 operations as a platform to plan enhanced efficiency, productivity and cohesion in our research, teaching, and outreach missions. The goal of infrastructure upgrading (e.g., the next generation Hosler building) would be to place additional emphasis on high quality, flexible laboratories equipped with state-of-the-art equipment designed for safe large-classroom instruction as well as world leading research. While the newly renovated Hosler building will be envisioned to fulfill the department needs for both research and teaching over the next 3 decades, facility upgrade regardless of the status of the building renovation will focus on acquisition of the latest equipment that can significantly advance the research and teaching mission of the department, develop infrastructure that facilitates collaboration between students, faculty, staff and researchers and showcases the extraordinary legacy of the department and its future aspiration to prospective students, faculty and researchers. The ultimate objective will be to provide flexible spaces to foster growth in enrollment, support students and faculty recruitment and retention, as well as encourage technological advancements in research.

**Objective Years:** 2020-2024

**Start Date:** July 2020

**Target Completion Date:** June 2024

**Key Performance Indicators:**

- Direct EME participation as contributing building stakeholders, with faculty, staff and student representation, to provide input into the facility upgrading process.
- EME Faculty, staff, and student readiness for a seamless transition into new spaces
- Make facility upgrading including the upcoming Hosler renovation as part of research, teaching, and outreach operations and planning in 2020-2024.

**Action items:**

- EME will work towards developing spaces that are as distinctive as the department itself and enable our goal of developing a more integrative community of energy and earth resource scholars. Emphasize the integrative nature of re-imagined department operations – the three interdisciplinary domain pillars bonded together with excellence in foundational science and analytical methods.
- Work with the EMS Development office to secure alumni and industry support for facility upgrading including enhancing the Hosler renovation (e.g. naming opportunities for classrooms, laboratories)
- Ensure that infrastructure renovation is designed around facilitating EME's increasingly integrative goals in education and research. Current research efforts are currently scattered across campus. As department's initiatives spin up new centers and pilot programs, it would become increasingly difficult for them to meaningfully interact with one another.