TEXAS A&M UNIVERSITY
Texas A&M
Energy Institute

TEES
Texas A&M Engineering
Experiment Station

CONVERGENCE RESEARCH
INCUBATOR

CO-RE

Progress Report

June 2020

BACKGROUND

What is happening in our world at this very moment, as we face a historic global pandemic, is a bold example of the complex and interconnected challenges we must expect to address as we move forward into the future. Addressing such complex challenges requires the development of **RESEARCH that innovates at the interface of multiple disciplines**. It also requires the active participation of **DIVERSE STAKEHOLDERS** from government, industry, private, and public sectors. For that to happen, essential infrastructure and mechanisms must be in place to enable rapid research and engagement responses to current and future grand challenges.

CONVERGENCE is an approach to problem-solving that cuts across disciplinary boundaries to integrate knowledge, tools, and methodologies from engineering, life and health sciences, and physical, mathematical, computational, economic, social, and behavioral sciences. **New funding opportunities for convergence research are anticipated in the coming year.** In preparation for these opportunities, the Texas A&M Energy Institute's **COnvergence REsearch (CORE) Incubator** will build upon the diverse expertise of its <u>faculty affiliates</u>, and expand its partnerships with academic, industrial, private and public organizations nationally, and globally.

<u>**CORE**</u> **aims to** provide an enabling platform to assemble and support interdisciplinary teams of researchers and relevant, multi-sectoral stakeholders to assist as the teams compete for external grants that demand proven records of cross-disciplinary collaboration.
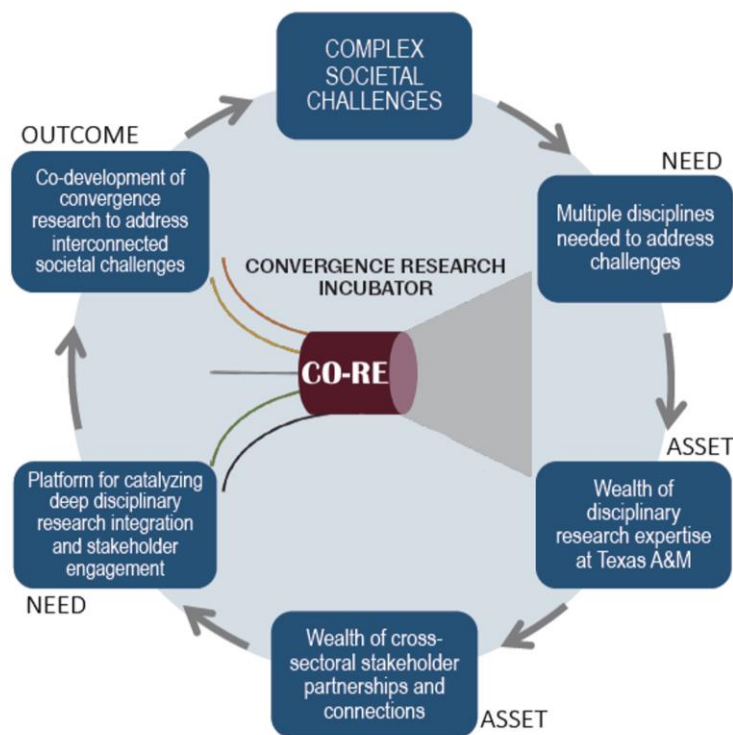
This document highlights the results of the survey conducted during April-May and in preparation for the **June 19 webinar** that will mark the beginning of the team formation phase.

CORE SURVEY

I- Survey goals

Following the April 21st webinar, a survey was sent to Energy Institute affiliates and webinar participants. The goals of this survey were to:

1. Take a bottom-up approach **in identifying the complex challenges** and **thematic areas** that Texas A&M faculty are currently working on or interested in addressing.
2. **Identify faculty/researchers** interested **in leading or supporting teams** to focus on one or more of these complex challenges.
3. Identify the **skills and expertise** of interested faculty/researchers
4. Identify the **complementary skills and expertise** needed to complete these teams.
5. Identify **main stakeholder groups** important to include on those teams
6. Identify **funding agencies** from which participating faculty / researchers can receive support for their research work

In addition to identifying relevant stakeholder groups, participating faculty / researchers were asked to share the survey with specific stakeholder contacts who could also respond to the survey, specifically about:

1. The **complex challenges faced** within their sector/institution
2. The **research disciplines and expertise** that can most help them in addressing these challenges.

The remainder of this report shares results from this survey. Details about stakeholder's responses to the survey will be shared at the upcoming June 19 webinar.

CORE Webinar – April 21, 2020

In case you missed the first CORE webinar, introducing the

initiative and its timeline and activities,

you can check it out here.
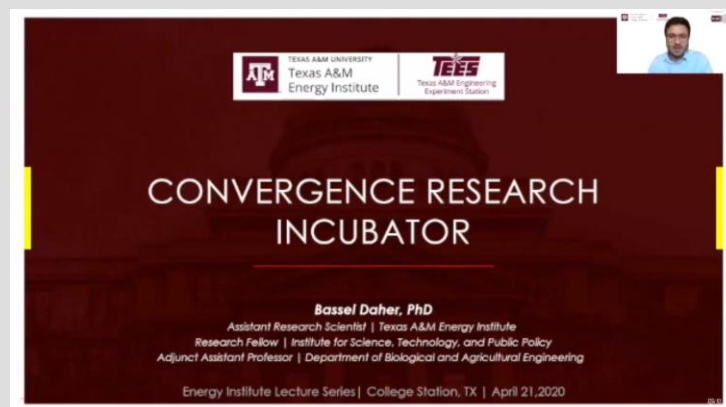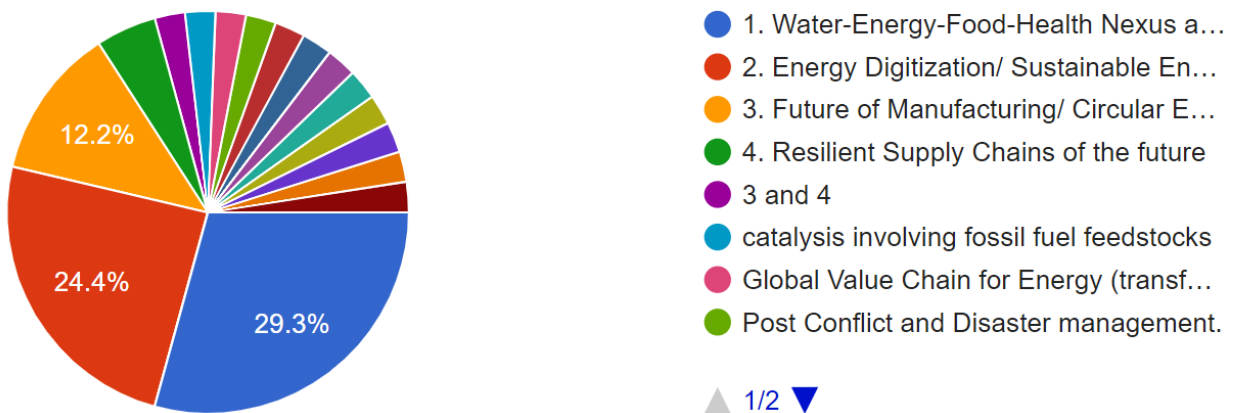
II- Survey highlights

- **46 survey responses:** 42 academics, 4 stakeholders

- **Academics across different departments including**: *Engineering (Electrical and Computer, Environmental, Chemical, Mechanical, Biological and Agricultural, Materials Science &Engineering), Environmental and Occupational Health, Public Service and Administration, Humanities and Social Sciences, Soil Crop Sciences, Health & Kinesiology - Sport Management, Information and Operations Management, MBS / Management, Chemistry, Geography, Atmospheric Sciences, Engineering Technology and Industrial Distribution, Public Service and Administration, Physics & Astronomy, History, Law, Architecture*

- **Stakeholders include:** Land owner/farmer in West Texas, US hydrocarbon exploration company, Youth Organization Leader**,** STEM consultancy

- **Top three thematic areas:** 1) Water-Energy-Food-Health Nexus and Sustainable Development Goals (29.3%), 2) Energy Digitization/ Sustainable Energy Systems of the Future, 3)Future of Manufacturing/ Circular Economies (12.2%).

- **20+** faculty interested in leading a team or finding new members for their existing teams

- **Key skills of survey participants include: *Modeling*** (geospatial**,** multivariate, microbial, experimental and numerical, systems, land change, Process Systems modeling, among others); ***Material sciences/engineering*** (membrane separation, catalytic/photocatalytic materials, superconducting technology, composites, nanomaterials, additive manufacturing (3D printing), experimental polymers and energy storage, among others); ***Data and computational sciences*** (data analytics, big data, computational methods); ***Social Sciences*** (stakeholder engagement, government policy and law, survey research, stakeholder interviews, participatory observation, focus groups, key informant interviews, photo- and mapping-interviews, game theory, tax policy, historical perspective and context, among others); ***Education & Diversity*** *and* ***Management.***

- **Key disciplines/skills needed to complement teams include:** Public health, kinesiology, wind energy, behavioral science, cognitive psychology; economics, medicine, physics, applied probability theory, community coping mechanism, techno-economic analysis, risk, project financing, machine learning.

- **Major stakeholders that need to be included:** Texas Department of Agriculture, Texas Recreation and Park Society, Texas Water Development Board, Department of Energy labs, City government officials; policymakers; selected private sector tech companies, Chemical Process Industry, Oil and Gas Industry, Utility Sector, International Organizations (UN Offices, European Commission), National labs, Federal Emergency Management Agency (FEMA), among others.

- **Past support primarily from:** NSF, DoE, DoD, USDA, UN, NIH, EPA, USAID and other foundations and private organizations.

III- Survey Results

1. **DISCIPLINARY EXPERTISE | Which of the following best describes your area of disciplinary expertise?**
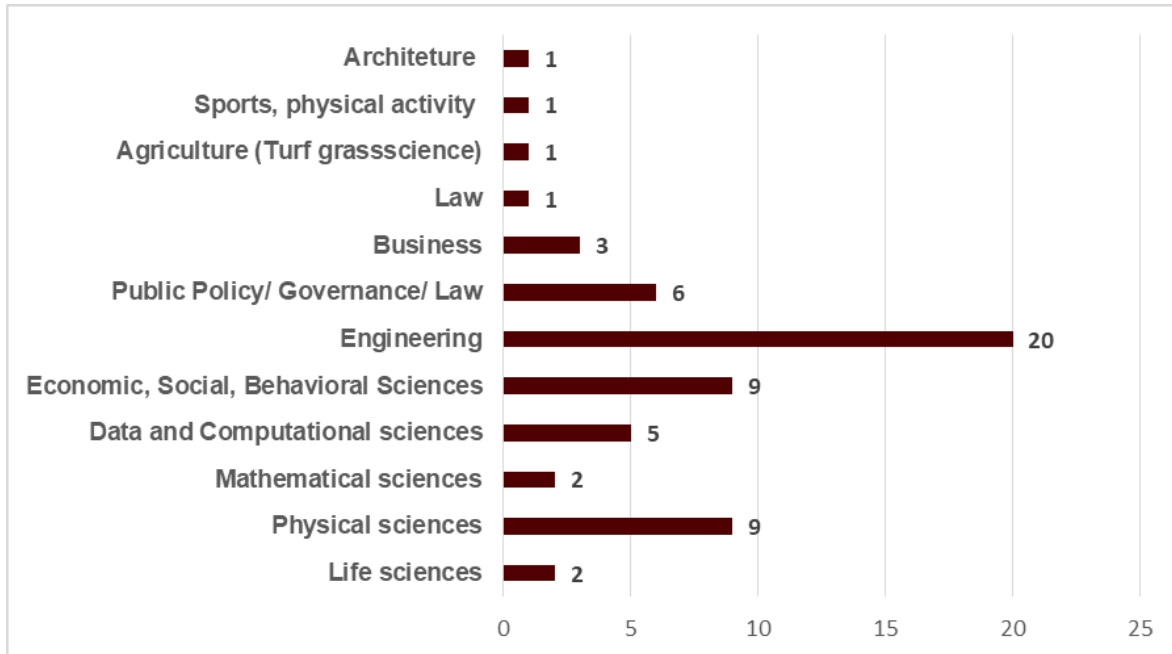
2. **THEMATIC AREA | Which thematic area most closely aligns with your research?**

- 1. Water-Energy-Food-Health Nexus a…
- 2. Energy Digitization/ Sustainable En…
- 3. Future of Manufacturing/ Circular E…
- 4. Resilient Supply Chains of the future
- 3 and 4
- catalysis involving fossil fuel feedstocks
- Global Value Chain for Energy (transf…
- Post Conflict and Disaster management.

▲ 1/2 ▼

The **top four thematic areas** indicated by survey participants are:
1. Water-Energy-Food-Health Nexus and Sustainable Development Goals (29.3%)
2. Energy Digitization/ Sustainable Energy Systems of the Future (24.4%)
3. Future of Manufacturing/ Circular Economies (12.2%)
4. Resilient Supply Chains of the future (4.8%)

Other thematic areas added by survey participants included:
1. Social and cultural contextualization of technological changes and advances
2. Public Trust in Science and Scientists
3. Petroleum

4.   Grid scale energy storage to flatten the curve
5.   Project Management / Future of Work
6.   Post Conflict and Disaster management.
7.   Catalysis involving fossil fuel feedstocks
8.   Carbon Management and Decarbonization
9.   Communication Security
10.   Regional politics of the Middle East
11.   Global Value Chain for Energy (transfer pricing); Taxation of Energy Industries

3. I am interested in:
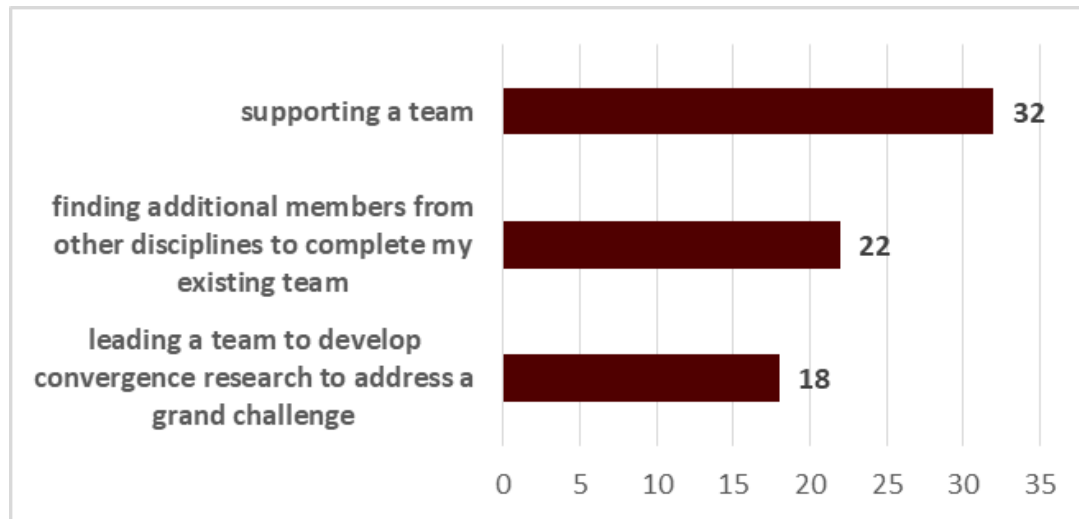
4. COMPLEX GRAND CHALLENGE | What complex grand challenges are you currently working on (or interested in supporting)?

4.1 Water-Energy-Food-Health Nexus and Sustainable Development Goals
- Water and Health
- Human Sciences and Policy
- Providing safe and accessible sports fields for human recreation (primarily youth), while also helping decision-makers take the most environmental and economically sustainable approach/ management and safety of community-level sports fields.
- Leveraging various business sectors to promote SDGs -sports sector
- Coordinate between ministries to set long term sustainable goals and investment decisions
- Metal-free batteries, recyclable polymers
- Water security with robust, dependable, and low cost energy sources.
- Energy, health, and environmental impact of urban cooling (A/C, refrigeration)
- Governance of the water-energy-food nexus; urban resilience; smart cities
- Machine Learning Accelerated Materials Discovery and Design for Energy Applications
- building new curriculum and incorporate innovative educational ideas
  Highly engaged with Disaster Resilience Issues
- Energy Workforce of the Future/ Circular Economy Projects
- Food security and food safety
- Leading a TAMUK resubmission with inter-institutional partners to the coming NSF-ECO_CBET solicitation.

4.2 Energy Digitization/ Sustainable Energy Systems of the Future

- Resilient and affordable electricity with low carbon footprint
- Tools availability
- Artificial intelligence to support computational fluid dynamics simulations
- alternative energies
- Health and environment
- Sustainable Development; Solar Energy Conversion
- Energy Technologies: From Concept to Commercialization
- Fusion tokamaks, superconducting wind turbines, superconducting transmission lines
- Quantum science

4.3 Future of Manufacturing/ Circular Economies

- Circular Economy
- Data science for energy
- Advanced manufacturing of parts and material with complex multi-functionalities to realize specific objectives including energy saving
- Defining the role of design and architecture in the Circular Economy

4.4 Resilient Supply Chains of the future

- Nexus governance; smart, sustainable, and resilient cities; resilient city critical infrastructure
- Material and energy consumption due to urbanization, impacts of these on ecosystems

4.5 Under the additional thematic areas included by survey participants

- How to make the transfer of technologies as part of aid-projects culturally appropriate
- Public Attitudes towards science and scientists
- Understanding how hurricanes and other natural disasters affect competition, supply chains, etc.
- Make solar (and other renewable) energy economical
- Healthcare Training
- Grand Challenges for Disaster Reduction
- Today's grand challenge is the disappearance of fundamental basic research
- Clean Energy Security: Fossil Fuels with Carbon capture or Renewables or Both?
- Communication security
- Global Value Chain for Energy (transfer pricing) and taxation's impact on sustainable energy investment

5. **SKILLS AND EXPERTISE | What main skills/ areas of expertise could you bring to an interdisciplinary research group? (ex: game theoretic modeling, machine learning, stakeholder engagement...)**

The following clusters of skills and expertise emerged from the survey responses. (We recognize that some inputs may not be an "exact fit" to the specific emergent cluster).

Modeling

GIS, remote sensing techniques, qualitative GIS, climate modeling, atmospheric chemistry modeling, multivariate modeling; machine learning force field for large scale all-atom molecular dynamics simulations; microbial modeling, post-harvest processing/storage/treatment of food and feed commodities, modeling and simulation; networking and telecommunications, computational dynamics simulations, experimental expertise in the area of thermal imaging, heat transfer characterization and analysis, experimental and numerical modelling of transport and reacting phenomena; concentrating solar power; reactor engineering; systems modeling, geospatial analysis, land change modeling, process systems modeling, multiscale optimization, process intensification

Material Sciences/Engineering

Membrane separation, water treatment and desalination technologies with energy recovery; nutrients removal/recovery, experimental polymers and energy storage, electronic structure theory and simulation of materials, interfaces and defects; discovery and design of novel solar absorber, battery, electrolyte, and catalytic/photocatalytic materials, superconducting technology, magnetics, 3D printing, experiment and modeling, composites, nanomaterials, Additive manufacturing (3D printing), Materials chemistry, nanoscience, nanophotonics, optics, nanomaterials, design.

Social Sciences

Stakeholder engagement, government policy and law, survey research, stakeholder interviews and surveys; economics, public policy and management analysis; risk perception analysis, qualitative research (participatory observation, focus groups, key informant interviews, photo- and mapping-interviews), policy-work, public opinion and stakeholder engagement, game theory, knowledge of the Middle East, politics of global oil market, tax policy, transfer pricing methods, comparative research and analysis, profit level indicator research, historical perspective and context, communication.

Data Sciences
Data sciences, data analytics, big data, computational methods.

Education & Diversity
Educational questions, Engineering education and assessment, diversity, technology transfer, capacity development, communication security

Management
Project and program management, partners' engagement, project management, proposal preparation

Thematic skills highlighted:
- Wastewater Reuse for Ag and Domestic Sectors, Water quality Solution of Water Pollution and Public Health,
- Environmental, climate change and agricultural skills
- Power systems
- Energy Analysis Renewable energy and waste management
- Dynamics of machinery, prognostic maintenance and digital twins
- Operations research, & energy storage technologies
- Catalysis and separation
- Hybrid energy application
- Contingency planning; preparation for Emergency, Recovery and development stages post disaster.

6. COMPLEMENTARY SKILLS AND EXPERTISE | What research disciplines/ expertise best compliment your research work?

The following clusters emerged from the inputs identified by survey respondents as skills and expertise needed to complement their research:

Thematic areas
- Environmental chemistry, water engineering, environmental sustainability and public health
- International migration, W-E-F nexus, developmental studies
- Public health, Kinesiology, Park and recreation tourism, Ecology
- Natural resources conservation
- Climate studies, human geography, behavioral science, marketing, decision making
- WEF, water treatment, alternative energy
- Environment and air quality
- Power electronics
- Wind energy

Disciplines/ focus areas needed
- Civil and environmental, mechanical engineering, electrical, and chemical engineering
- Cognitive psychology; economics
- Construction, materials science
- Science, Engineering and Medicine
- Conservation, climate science
- International Affairs, Political Science

- Physics
- Operations research, applied probability theory
- Community coping mechanism
- International investment, project financing, economics, risk

Social sciences skills and expertise needed
- Community/stakeholder engagement, law and policy, policy, sociology
- Scientific analysis of resource subsystem- how resource subsystem of a country can be affected by decisions taken in silos by other ministries.
- Techno-economic analysis
- Qualitative social science

Modeling/computation needed
- Energy modeling, integrated assessment modeling, computational methods; modeling and simulation; networking and telecommunications and EM, Statistical analysis and model fitting
- Theoretical/computational modeling, data science, machine learning

Material sciences needed
- Materials science, chemistry
- Synthesis and characterization of novel materials as well as device characterization
- Membrane separation, water treatment and desalination technologies with energy recovery; nutrients removal/recovery. Materials; catalysis; systems
- Materials Science and Chemistry, Materials science for energy applications
- Industry scale up

7. STAKEHOLDERS | What are examples of stakeholders or stakeholder groups you think would be important to involve in the co-creation and development of your research?

- *Locally - Texas Department of Agriculture, Texas Recreation and Park Society, Texas Sports Turf Managers Association, Texas Amateurs Athletics Federation, University Interscholastic League, Texas Water Development Board*
- *International Organizations (UN Offices, European Commission) but also local communities and industrial partners.*
- *Think tanks, HVAC, chemical manufacturing*
- *Policymakers and public program managers; nonprofit organizations*
- *National labs, potential material/device companies*
- *Department of Energy labs*
- *Agricultural and animal facilities group including all commodity group*
- *NanoInnovation LLC*
- *City government officials; policymakers; selected private sector tech companies*
- *Environmental and health advocacy groups*
- *Federal Emergency Management Agency (FEMA)*
- *All oil and chemical companies*
- *Chemical Process Industry, Oil and Gas Industry, Utility Sector*

8. FUNDING | What are examples of funding agencies that support your area of research? (governmental, private sector, other)
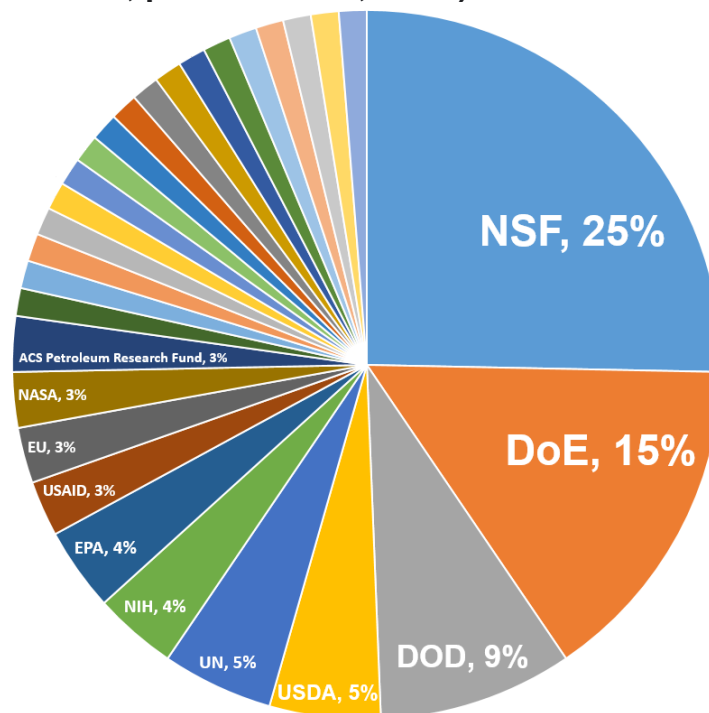
In addition to the funding institutions visible in the figure, other institutions include: NOAA, NHS, USDOT, Office of Naval Research, Foundations (Kellogs, DiCaprio, Welch, Gates), Keep America Beautiful, Public Land Trust, Qatar National Research Fund, International Olympic Committee, The Nature Conservancy, ARL, oil and gas sector, State agencies, State commodity groups, ConDev (TAMU).

TIMELINE

PHASE I   PHASE II

SPECIAL ISSUE
DEC 2020

TODAY!   MAY 15   JUNE 1   JUNE 19   JULY   AUG 2020

SIGN UP on CORE webpage

SURVEY
• Grand Challenges
• Lead/Support
• Skills/Methods

SURVEY RESULTS

WEBINAR
• PITCHES
• Team Formation
  ➢ 1 EI affiliate;
  ➢ 1 non-academic stakeholder/ extension
  ➢ cross-college collaboration
  ➢ cross-institutional collaboration

2-PAGE CONCEPT NOTE

SEED GRANTS
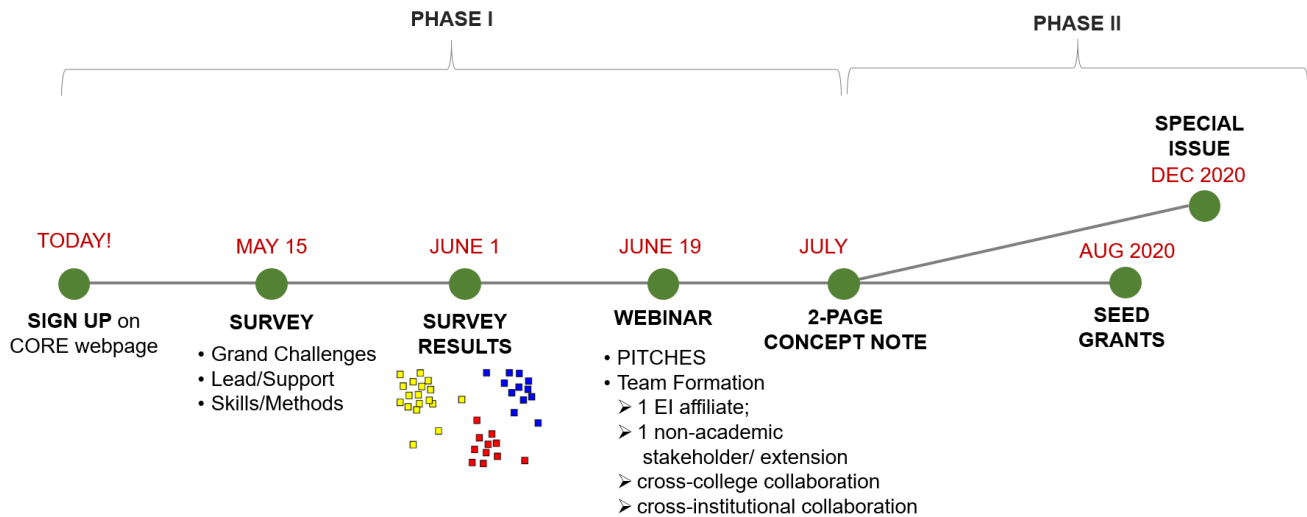
Following this initial survey, the next milestone will mark the beginning of team formation. The upcoming June 19 webinar will include short elevator pitches by faculty and stakeholders who indicated interest in leading a team. This will be a chance for those participating at the webinar to identify potential teams to join and partner with toward developing the 2-page concept notes.

Please share this invitation widely within your network of faculty and cross-sectoral stakeholders who might be interested in participating in this activity.

SAVE THE DATE

CORE WEBINAR

JUNE 19 @12-2:30 PM

REGISTER HERE

This webinar will include:
1- Keynote by NSF Program Officer for Growing Convergence Research
2- Highlights of CORE survey
3- Elevator pitches by faculty and stakeholders
4- Team formation and next steps

For more information

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