CEAC Purpose
The Controlled Environment Agriculture Center (UA-CEAC) of the College of Agriculture and Life Sciences at the University of Arizona is a research, teaching, and outreach program of the College. CEAC, through its staff and faculty, focuses on innovative technologies for the generation of food, bioenergy, and bioproducts to:
- Develop challenging research programs with application in science, engineering and practice;
- Educate students in a variety of settings and for varying purposes in best practices, creative approaches to problem-solution, engineering, and the methods of science; and
- Facilitate programs, events and materials for industry and the general public to learn more about the importance which Controlled Environment Agriculture (CEA) has in meeting current and future problems with creative, practical, and highly successful solutions.
CEA integrates science and engineering to maximize plant and biosystems productivity so that regulated, engineered environments have the capacity to maximize production and optimize use of resources including:
- Water • Energy • Land & Space • Capital & Labor and • Human Satisfaction.
CEAC has special, but not exclusive, focus within environments which are Arid, Semi-Arid, Urban and Extreme.

CEAC Vision
CEAC maintains and enhances global leadership, advancing CEA, by working to develop economically, socially, environmentally, and scientifically sound and sustaining agricultural methods, practices, knowledge, and results.

CEAC Mission
- Expand the science, technology, engineering and practical application of CEA while optimizing uses of water, energy, labor, land, human enterprise and other resources;
- Extend the knowledge and understanding of CEA to all Stakeholders and relevant Communities;
- Demonstrate that CEAC research can resolve significant plant and biosystems production challenges;
- Collaborate with University of Arizona departments and programs, other science, engineering and governmental organizations worldwide to promote and facilitate innovation and creative applications of CEA technology;
- Communicate CEAC programs and achievements, advances an action-reflection approach, increasing worldwide recognition, appreciation and information flows, for Research, Education, Extension and Outreach;
- Build a prosperous future where CEA assists global agriculture to produce clean, safe, abundant and affordable food for all.

CEAC Shared Values of Faculty, Staff, and Students
- Dedication to CEA - to enhance the knowledge and experience base for CEA, supporting applications of CEA in Arizona, the USA and the World.
- Dedication to our Professions - to each individual profession, working toward advancing practiced disciplines such as represented by ABE, SPLS, SWES, and others.
- Collaboration with Academic and Research Programs - to promote study and education with other academic programs at UA and throughout the world.
- Partner with Business & Industry - to help partners in business and industry to adopt CEA technology in feeding the people of the world with attention to security, nutrition, resource savings, safety, market needs and cultural constraints.
- Pursuit of Excellence - in professional, research, teaching and practice behavior; observing fairness, openness, and ethical demeanor, diversity, cooperation, communication and productive competition at UA and beyond.
Notes – Background

In 1998, the Arizona legislature, on recommendation from Governor Jane Hull, appropriated recurring funding of $700,000 a year to establish and operate the University of Arizona Controlled Environment Agriculture (CEA) program. There is a commitment for Plant Sciences (SPLS), Agricultural & Biosystems Engineering and Agricultural Education Departments (AgTech Management), which has been strongly encouraged, carefully organized and highly supported by the College of Agriculture and Life Sciences, to establish this multi-disciplinary educational, research and extension program in CEA. The Arizona greenhouse hydroponic vegetable crop production industry has invested more than $188 million during the past 11 years, to establish more than 250 acres of new construction specifically for vegetables, beyond the initial 100 acres. During this time period, the State has provided $7.2 million for UA-CEAC, representing a 25-fold leverage on funds. These greenhouse businesses became successful, in part, because of the favorable conditions within Arizona, including, a pleasant winter climate, sufficient high quality water and energy resources, efficient transportation infrastructure, and an available labor pool, but also with the activities of CEAC.

Although there is no ‘CEA Department’ with its ownership of a CEA academic program, there are faculty, staff and students from various departments, who are interested in biological and engineering projects related to CEA, who are brought together into project teams as part of the CEA program. These people participate at various levels and in complementary combinations of backgrounds within the education, research and extension programs and projects that support the Purpose, Vision and Mission of CEA. The world is asking for help. We have the expertise and the facilities to provide services. We have the wherewithal to develop more (combined CEA experiences of CEAC faculty and staff amount to more than 275 years). We function within a climate which represents 40% of the world’s current development in CEA. There is a lack of education/expertise of people within the CEA industry (whereas there is a large pool of traditional field vegetable crops growers). There are limited research and teaching facilities throughout the USA and North America. CEAC has the potential, with the support of CALS and UA mechanisms, for developing self-support to expand to meet the demands.

CEAC is transfixed at the crossroads of the world’s initial experiences of finite resources for food production, and their resurgent desire for safe, secure and healthy foods. This is one of our strengths. We can remain at this high point of interest and support for the CEAC (and improve on it) because of the CEA technologies that are being researched, demonstrated and taught for future improvements, and for what we do today at CEAC in education and development of solutions using those technologies. Students both in USA and worldwide are looking to us for their educational programs leading toward careers in the food production industry. Agricultural businesses are planning financial support to facilities development for CEAC. The world has come to recognize UA-CEAC as one of the authorities on modern CEA during its 12 years of existence, and with foundation of 40 years of experiences at the UA in CEA at the Environmental Research Laboratory (ERL).

CEAC has had budget reductions equivalent to 50% for total operations since its inception; however through faculty and staff efforts it has procured other means for funding for operations to cover critical operations. We are stable but need to maintain our current faculty while expanding staff services to enhance the programs. The state funds are provided each year to CALS and are distributed to both the Department of Agricultural and Biosystems Engineering (ABE) and School of Plant Sciences (SPLS) for operations and faculty support of the CEAC and its interdisciplinary programs. The salary funds are available for the CEAC program.

A new educational and training greenhouse facility is being planned with support from the industry, to provide experienced growers for the future of the industry. It could operate as a full-time 3 ½ month class for 75 students per year, at $15k each for $1.1M per year; plus, the sale of tomato product of 1M lbs. within 2.5 acre facility, providing $1M income from sales. Total yearly revenue is $2.1M; total construction cost is $5.5M; total operations cost is $500k per year [all estimates]. The business plan is in development. The expectation is for a semi-independent education/production facility, run as a business, and which makes a profit of benefit to CEAC. This educational facility is expected to become the singular and premier facility [and only one in the USA] and in North America, as well, with CEAC geographically located at the “center” of the North American greenhouse produce industry in Canada, USA and Mexico.
CEAC STRATEGIC GOAL #1: Enhance and communicate our standing as a world leader in CEA plant & biosystems production through Research, Education, Extension & Outreach (REEO)

A. Current situation and gap between current situation and desired situation

- Since 1998 (see note above), the CEAC is the only comprehensive educational program in the United States for CEA, with full complements of activity in Research, Education, Extension and Outreach (REEO).
- While Research, Extension, and Outreach increases, potential undergraduate and graduate students are not aware of CEAC for their education.
- CEAC activity must garner support from new capital sources to assure sufficiency to maintain current needs, and for new opportunities. CEAC Research is expanding LED lighting design and application; sensor systems knowledge and application of software-driven optical sensing systems; bioregeneration systems for greenhouse and space applications; flavor and plant biochemical enhancement; multi-crop of plant and seafood.
- All CEAC classes are “hands on” and require specialized facilities, limiting the numbers of students. Additional world-class facilities are needed to attract and serve more students. The annual CEAC ‘Greenhouse’ Extension courses, intensive training programs, one-day workshops, Outreach to schools and other groups, include a global potential student and participant population.
- A gap in support systems (e.g., financial, organizational, institutional, governmental) currently persists, potentially threatening the growth and viability of CEAC if left unchanged.
- Current Outreach programs in North America, include presentations on global video in broadcast, cable and web-sites and functioning demonstrations serve to attract students and support for CEAC.

B. Strategies

Research: Regular evaluation of relevant CEAC activities to keep on track in meeting this Goal.

Education: Increase communication access and visibility for students at all levels.

Extension & Outreach: Establish new and enhance existing programs. Establish partnerships with media, institutions, NGOs.

C. Actions & Time Period in Fiscal Years

Research: Evaluation of CEAC REEO programs and all relevant CEAC activities FY 12-21

Education: Increase our visibility, understanding & recruitment for students at all levels by cultivating 2 + 2 programs with Arizona community colleges (FY 14-17); and, create & enhance availability of courses to agricultural business FY 12-21

Extension: Create CEA Specialty Crops Support Program especially for small growers; Create the first North American CEA Education/Training Center (ETC-GH); and, Develop staff for program coordination and agriculture markets development (FY 12-14); Increase annual Short Course and intensive education offerings; Increase Fee-For-Service CEA design analysis and advisory services FY 12-21

Outreach: Develop a National CEA Organization and align with similar international groups (FY 12-15); Create a certification program for CEA employees (FY 13-21); Create a cross-channel template for “products” of CEAC (foods, systems & services) (FY 14-21); Access opportunities to increase CEAC visibility and understanding for Stakeholders (FY 12-21); Establish partnerships which can maintain and extend CEAC (FY 12-21); Make CEAC the global CEA clearing house on CEA issues, solutions, and certifications for business and industry FY 13-21

D. Inputs needed to achieve the goal -- Funding, Planning & Execution

E. Objective Metrics that will be used to track progress towards attaining goal

- Usual academic metrics (publications, citations, etc.) for recognition in professional research community
- Growth of the CEA food production industry (value of products; “% locally grown” products; etc.
- Distribution, demographics and programs activities of students participating in the CEA programs
- Amount of financial resources that become available for support of the programs
CEAC STRATEGIC GOAL #2: Create applications of CEA for a game change in food production systems by 2021

A. Current situation and gap between current situation and desired situation

- North America has increased greenhouses for food production. The volume contribution is relative small but the economic value and application value is tremendous. However, there is limited public understanding of the use of CEA technology. Open field agriculture is better understood.
- UA-CEAC is a unique academic center in North America with focus on REEO, which has been successful in technology development for crop productivity and quality, but further emphasis is needed with regard to environmental impacts (i.e. resource conservation)
- There is an increasing demand in urban horticulture and alternative food production systems, but the capacity to serve all Stakeholders and to develop opportunities is limited by current UA-CEAC resources
- There are worldwide demands to employ CEA to solve interconnecting issues of “feeding/nourishing the world”, “environmental impact”, “limitation of resources”, and “meeting market demands”.

B. Strategies to achieve goal

- Identify, plan and develop key interrelated REEO initiatives at CEAC. The initiatives will be changed or modified based on funding agencies missions and emphases. Examples include:
  - Urban food production REEO initiative (USDA); Plant factory REEO initiative (USDA; NSF-vertical farming project); and, Plant-animal or plant-fish co-culture system REEO initiative (USDA-WRAC, SARE, USAID); Green energy integrated CEA systems (NSF, DOE, SARE, USDA, USAID); and, SmartCEA (intelligent sensing and controls) initiative (NSF, SBIR, STIR, USDA, private sector)
  - CE education, research and IT&K transfer initiative to “feed the future” (USAID); and, Public education and K-12 programs (LGH-OTM, NSF-FIRE-REESE grants)
  - Develop collaborations with expanding algae culture industry in Arizona

C. Actions & Time Period in Fiscal Years

Develop research/extension initiatives at CEAC
- Initiative development planning, action initiatives & create working groups FY 13-14
- Obtain seed capital for planning and development activities FY 13
- Development & planning for innovative funding in CEAC self-support FY 12-13

Enhance communications and collaborations for CEAC
- Communications system planning, design, implementation; Communication, aimed at an action-reflection approach for continuous improvement of REEO FY 13
- Develop seminar series and publication and other media programs FY 13

Organize program for use of existing CEA facilities to support entrepreneurs and small business
- Continue negotiations with relevant UA leadership and other Stakeholders FY 12
- Plan for Marketing and Implementation of Program FY 13-21

D. Inputs needed to achieve the goal

- Grants (seed and other) & other supports for activating strategic programs listed in B
- REEO & Communications Planning & Design
- Innovative financing through various opportunities including grants, fees-for-services programs, proprietary product development and sales, partnerships, certification programs, cooperation with international agri-businesses, etc.

E. Objective metrics that will be used to track progress towards attaining goal

- Number of projects and total dollar values funded relevant to this goal;
- Number and quality of entrepreneurs supported through the program;
- Number of seminars supported through the program;
- Number and quality of web contacts (website, social media, etc.);
- Number and quality of visitors to events; Number of students in classes and training programs.
CEAC STRATEGIC GOAL #3: Enhance CEA Innovation, Technology and Knowledge (IT&K) transfer

A. Current situation and gap between current situation and desired situation

- Rising costs of resources, shortages in skilled labor, market changes, and global competition challenge the US food and floriculture CEA industries. CEA complements field production agriculture in Arizona. Resource limitations will affect all production agriculture.
- CEAC Research has focused on improving CEA technology for crop productivity and quality, while additional emphasis is needed for innovation, technology development and transfer. There is a specific need for adaptive, innovative, resource conservation responsive CEA systems in arid, semi-arid, urban, and extreme climates.

B. Strategies to Achieve Goals

- Work with University of Arizona Research Corporation (UARC) and other agencies for the development of IT&K transfer.
- Translate research activities into state-of-art facilities, processes, and product development with IP protection and patents
- Create and promote a support mechanism to work on innovative projects and technology transfer (i.e. legal, financial, technical, and promotional)

C. Actions & Time Period in Fiscal Years

- Effectively present the CEAC mission globally through effective, timely communications, with consistent messaging, professional imaging, & innovative result-oriented media and venues  
  FY 12-13
- Review CEAC REEO on IT&K transfer and conduct “needs” assessment with growers and private sector to develop targeted initiatives  
  FY 13-14
- Increase global team building for IT&K transfer projects  
  FY13-15
- Develop CEAC Global Business & Industry Advisory Board  
  FY 12-21
- Increase SBIRs (i.e. USDA AFRI, NSF, DOE, DOD, STEMs, Business Sources, Partnerships)  
  FY 13-21
- Establish effective CEAC model for tech transfer, IP and patent applications  
  FY12-13
- Establish effective CEAC model for entrepreneurial “fee-for-service” processes  
  FY12-13
- Utilize Graduate Interdisciplinary Programs (GIDP) CEA track  
  FY 13-21
- Transfer aquaculture and aquaponics program from ERL into the CEAC  
  FY 13+

D. Inputs needed to achieve the goal

- Global and diversified collaboration on strategic initiatives
- Participation of industrial and grower partners for development and investment
- Collaborative support of UA administration, ABE, SPS, UARC, and CEAC faculty and staff
- Enhanced REEO facilities, capabilities, and professional development opportunities
- Diversified funding with traditional and non-traditional sources to support faculty, staff and students

E. Objective metrics that will be used to track progress towards attaining goal

- Total dollar values of grants obtained leading to IT&K and technology development
- Number and effectiveness of partnerships established and leading to IT&K development and transfer
- Number and impact of economic value (jobs, dollars, etc.) originating from IT&K development
- Number and total revenue generated from IP and patents
- Number of students, staff, and trainees, degree program students graduated, employed in industry, etc.
CEAC STRATEGIC GOAL #4: Become financially self-sustaining

A. Current situation and gap between current situation and desired situation

- Since 2000, the $700,000 annual State funds have been reduced to $300,000 per year.
- CEAC faculty win on average $500,000 yearly through traditional means (grants, etc.) to support R&D and educational projects. These funds cannot be used for the Center’s operational and maintenance costs. State funding reductions have begun to consume the ‘seed corn’ of the Center, and this will eliminate critical programs and projects and people who have become the backbone of CEAC.
- CEAC personnel have goals and aspirations for the CEAC and for each of our own expanding professional careers. We expect greater coordination and teamwork across CALS and the UA through their departments of contracts, programs, finances, legal, graduate and undergraduate schools, etc.
- CEAC requires improved financially sustainable practices to maintain and grow the Center to meet the worldwide demands of CEA.
- The gap needs to be bridged for these capacity building functions.

B. Strategies to achieve goal

A comprehensive review is required of the current CEAC REEO, design analysis services, communications, and business development activities of CEAC faculty, staff, students, supporters, benefactors, etc. It will require input from beyond the campus borders and will assure legal and ethical applications, while maintaining the Vision and Mission of the CEAC and its parent organizations (CALS, UA). With targeted stakeholders, internal leadership, faculty and staff, etc. we will evaluate potential financially supporting opportunities, including but not limited to:

- Development of an advisory board of globally acknowledged external supporters to provide advice; ‘connections’; political support; annual funding sourcing.
- Development funding opportunities for supporting innovative projects, exceptional students, unique faculty needs, travel capabilities, visiting scholars, and industry partnerships.
- Developing alternative fund raising strategies in coordination with business development expertise resident in CALS, UA and the CEA community.

C. Actions & Time Period in Fiscal Years

- Complement the Actions as outlines in the three CEAC Goals described above FY 13-21
- Increase the CEAC yearly financial support for an anticipated ROI of 3:1. Return to the 2000 CEAC funding [$700k per year] for FY 12-13 with a decreasing yearly amount over the subsequent 10 years, to reach a minimum [current faculty/staff salary demands of ~$300k], allowing the opportunity for CEAC to establish permanent outside funding sources FY 13-22

D. Inputs needed to achieve the goal

- Commitment of CALS and UA to work with CEAC to maintain the integrity of CEAC human capital, its facilities, and its national/international components, and especially the ‘spirit’ of the State Decision Package of 1998.
- Changes to the CALS and UA fiscal policies with the goal to have both policy and leadership/staff being supportive of entrepreneurial activities.
- Immediate CEAC Faculty and staff salary adjustments to remain competitive.
- CEAC adjunct faculty and special supporters to be recognized.
- Support in the form of staff employment, investment from industry, relationship with growers, and collaboration of UA faculty

E. Objective Metrics that will be used to track progress towards attaining goal

- Complement the Metrics as outlined in the three Goals described within this document
- Donations and support from CEAC graduates and private sector