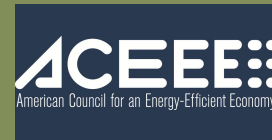




RESOURCE
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USDA CEA MARKET CHARACTERIZATION REPORT LAUNCH

*Data-Driven Market Transformation
for Efficient, Sustainable CEA*

October 26, 2021



United States Department of Agriculture

Natural Resources Conservation Service

Agenda

Welcome & Introductions / Derek Smith, RII	11 a.m. ET
USDA Landscape / Lucas Isakowitz, NRCS	11:05 a.m. ET
NRCS Objectives	
CIG Grant Program	
Project Overview / Derek Smith, RII	11:15 a.m. ET
Market Characterization Process / Jen Amann, ACEEE	11:20 a.m. ET
Findings & Recommendations / Gretchen Schimelpfenig, RII	11:25 a.m. ET
Next Steps: Market Transformation / Derek Smith, RII	11:45 a.m. ET
Q & A / Open Forum	11:50 a.m. ET





SECTION 01

WELCOME & INTRODUCTIONS

Today's Speakers



Derek Smith



Lucas Isakowitz



Jen Amann



Gretchen Schimelpfenig



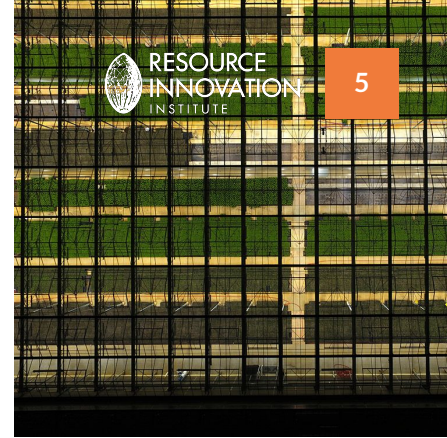
About Resource Innovation Institute

Objective, data-driven non-profit

Founded 2016 in Portland, Oregon

Expertise in climate policy, utility programs, green building certification, sustainable business, construction & indoor cultivation

In 2020, received 3-year grant from USDA to develop KPIs, standards & building rating system for CEA



What We Do / Our Mission

We measure, verify & celebrate the world's most efficient agricultural ideas.



Measure

Efficiency & Productivity

- Key Performance Indicators
- Benchmarks
- Baselines



Verify

Best Practices & Standards

- Training
- Policies
- Utility Programs



Celebrate

Leadership Recognition

- Verification
- Case Studies
- Certification



SECTION 02

USDA LANDSCAPE

NRCS -National Resources Conservation Service

NRCS provides farmers and ranchers with **financial and technical assistance** to voluntarily put conservation on the ground, not only helping the environment but agricultural operations too.



United States Department of Agriculture

Natural Resources Conservation Service

nrcs.usda.gov/



CIG - Conservation Innovation Grants

- CIG program has been operating for nearly 20 years and aims to support the development of innovative new tools, approaches, practices, and technologies to further natural resource conservation on private lands

CIG Classic

- Funds the development of promising approaches and technologies—which may or may not be successful!
- Funding rarely provided directly to producers

On-Farm Trials

- Funds the implementation and evaluation of innovative approaches, systems and practices that we know provide a conservation benefit
- Funding must be provided directly to producers to offset implementation risk



nrcscig@usda.gov

CIG - What is Innovation?

Innovation Is...

- Transfer of an approach/technology from a proven ag sector or geography to a new one
- Demonstration of a new technology that has shown promise in controlled settings
- Demonstration of a new approach for financing private lands conservation
- Demonstration of a new approach for incentivizing producer adoption of conservation practices and systems

Eligible Entities:

- Private entities whose primary business is related to agriculture
- NGOs with experience working with agricultural producers
- Non-Federal government agencies

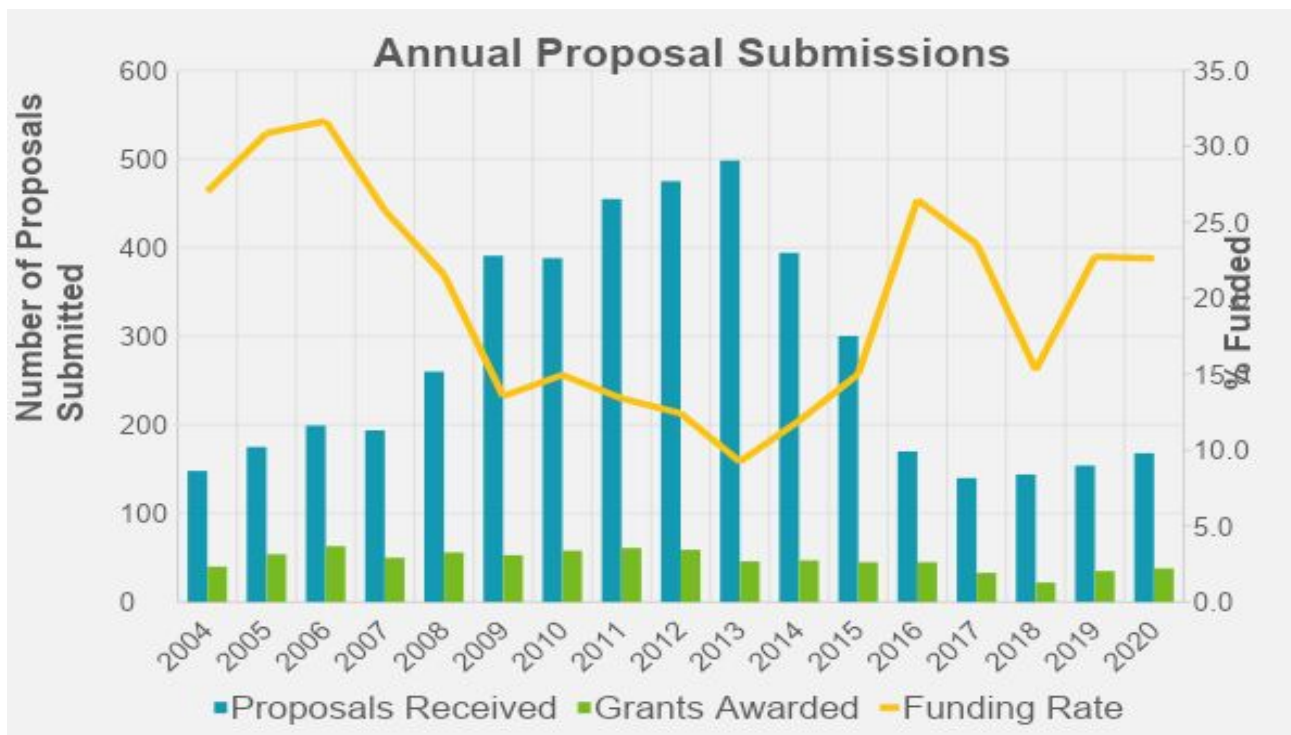
2021 Climate Action Plan

Published in October 2021

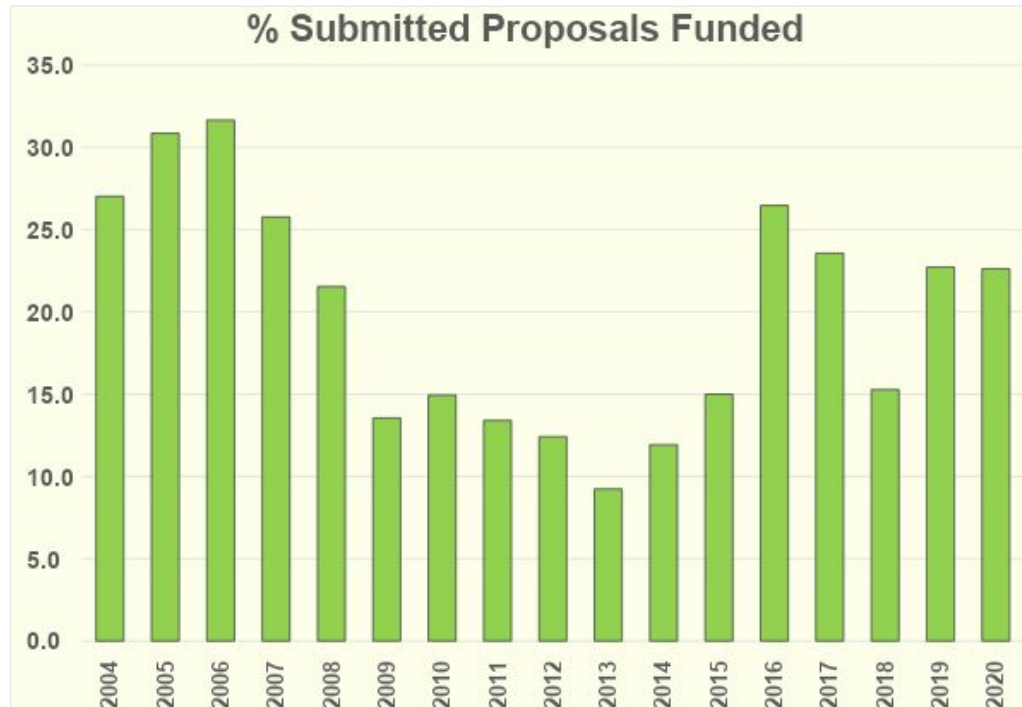
- Describes five vulnerabilities due to climate change that USDA has identified and must address
- Five actions USDA will implement in its mission, programs, operations, and management in anticipation of and in response to a changing climate
- “Increase support for research and development of climate-smart practices and technologies to inform USDA and help producers and land managers adapt to a changing climate... supporting participation in voluntary carbon markets, **renewable energy development and energy efficiency activities...**”



CIG Proposal Submissions



Percent of CIG Proposals Funded



About this CIG Project

Data-Driven Market Transformation for Controlled Environment Agriculture

- Applied in 2020 under the Energy Conservation Priority Area
- NRCS Award: \$595,026
- Key words from the 2020 National Funding Opportunity
 - **NRCS seeks proposals for innovative ways to increase energy conservation on agricultural operations**
 - **Energy use index to assess, initiate, and evaluate baseline conditions; prescriptive list, rebates, or other protocols to streamline adoption; real-time data to**
 - assess performance
 - to refine methods and **identify and implement efficiency and renewable resources**



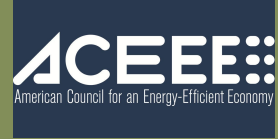


SECTION 03

PROJECT OVERVIEW



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Data-Driven Market Transformation for Efficient, Sustainable CEA

Launched 2021

Funded through 2023 by:



United States Department of Agriculture




Natural Resources Conservation Service



Grant Objectives & Timeline

 Deliverable

 Milestone

Scope	2021	2022				2023			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Market Transformation Strategy									
PowerScore Benchmarking Reports on Energy and Water KPIs, Baselines, & High-Performance Strategies, Pre- and Post-Project Reports									
Best Practices Guides and Case Studies for CEA: Lighting, HVAC, Design & Construction, Controls, Irrigation & Water Reuse									
Best Practices Guidance for Local, State and Federal Policy, Energy Codes, and Industry Standards									
Best Practices Guidance for Utility Program Design & Market Engagement, CEA Excellence Network, CEA Professional Credentialing									
Voluntary Certification System and Key Performance Indicators for CEA									

Project Impact: Emissions Benefits

The beneficial environmental impacts of the project will be achieved by working directly with 5- 10 producers to improve the energy efficiency of their CEA operations, with estimated benefits:

Avoided Greenhouse Gas Emissions

- Up to 1,904,200 kg CO₂eq from projects*

Equivalent to:

- Greenhouse gas emissions from nearly 4,800,000 vehicle miles traveled



*This estimate assumes a 4:1 mix of greenhouse to indoor vertical farms participating in our project.

Project Impact: Energy Savings

Energy Savings Benefits:

- Up to 25.8 million kBtu from envelope, lighting, HVAC, and controls measures*

Equivalent to:

- CO₂ emissions from 645 homes' annual energy use

Table 8: Energy Savings Potential by Measure

<i>Energy Savings Measure</i>	<i>Energy Savings Potential</i>
Greenhouse Envelope Systems	5 - 50%
LED Horticultural Lighting	30 - 40%
High Performance HVAC Systems	20 - 30%
Integrated Controls Systems	15 - 30%

*Savings are based on facility energy use estimates reported in ACEEE 2018 and an assumed 20% savings for implementation of efficiency upgrades.

RII's USDA Project Advisory Group



An aerial photograph of a city grid, viewed through a window with a dark, grid-like frame. The image shows a mix of green spaces, roads, and buildings, with the grid lines of the window creating a pattern over the city below.

SECTION 04

MARKET CHARACTERIZATION PROCESS

About Market Transformation

Market transformation is the **strategic process** of intervening in a market to create **lasting change** in market behavior by **removing identified barriers or exploiting opportunities** to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice.

About Market Transformation

Three **must have** components of any MT initiative:

In-depth knowledge
of the targeted
energy efficiency
market

Clearly defined
intervention strategy
and key leverage points

Policy/regulatory
framework
supporting the
intervention strategy



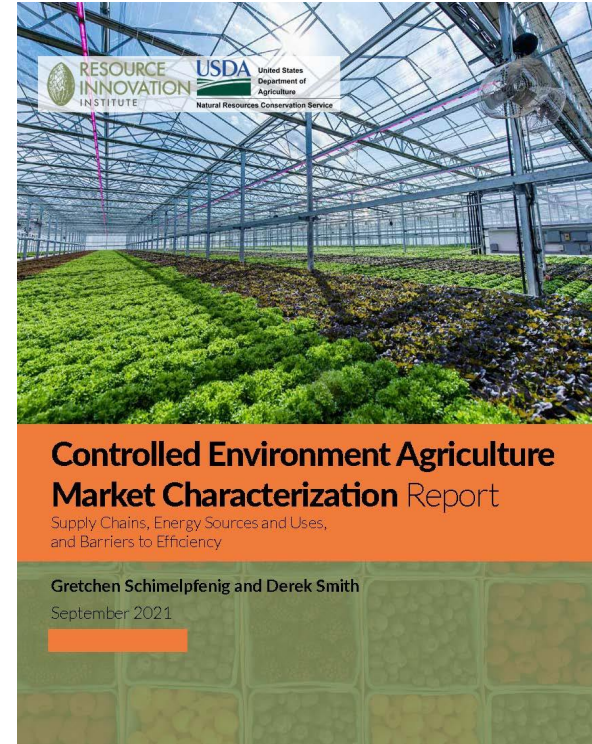
Market Characterization Report

What it is:

- Based on primary and secondary research: lit review, surveys, interviews
- Precursor to Market Transformation Strategy

What it is not:

- Precise
- Exhaustive
- Technology baseline study

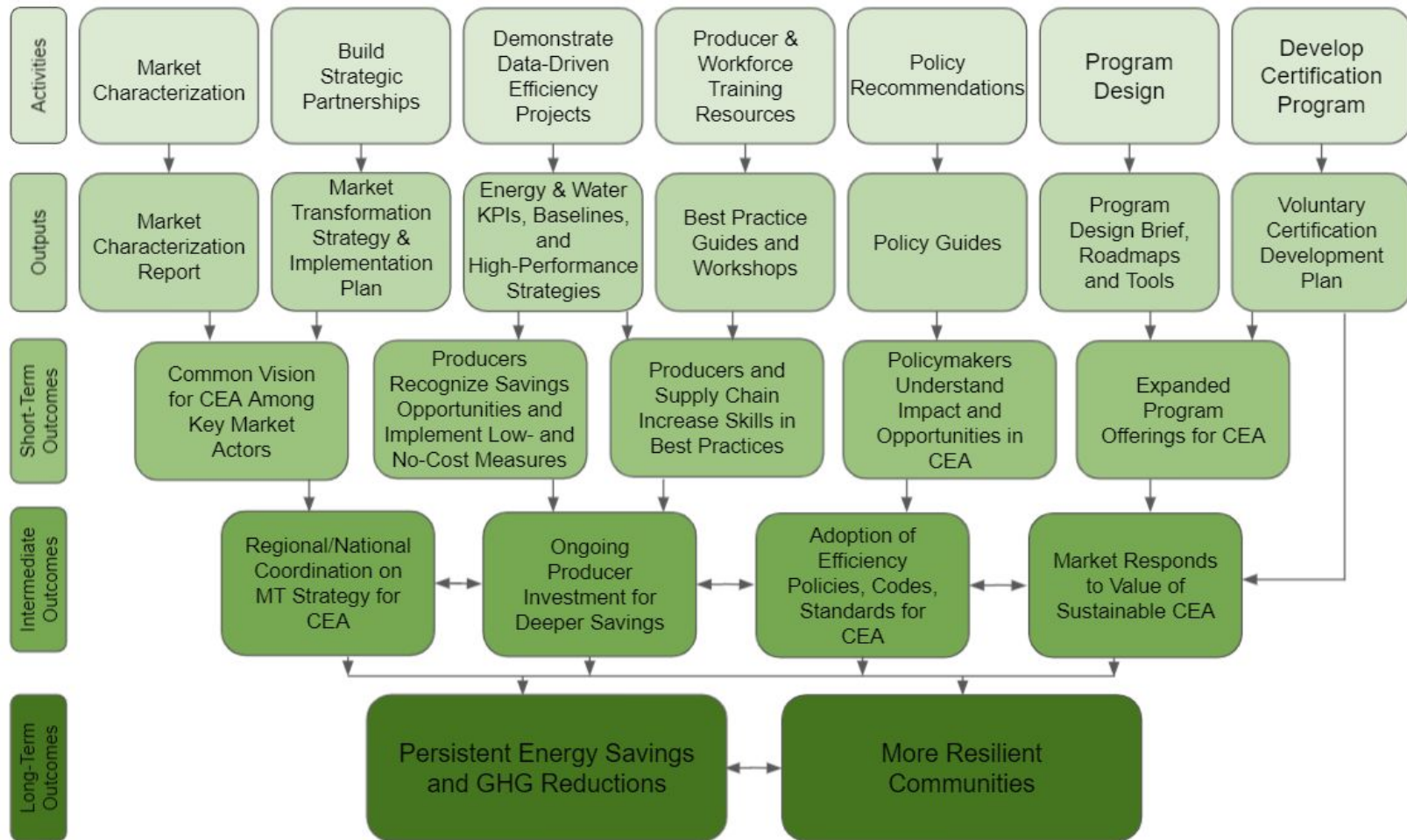


Research Objectives

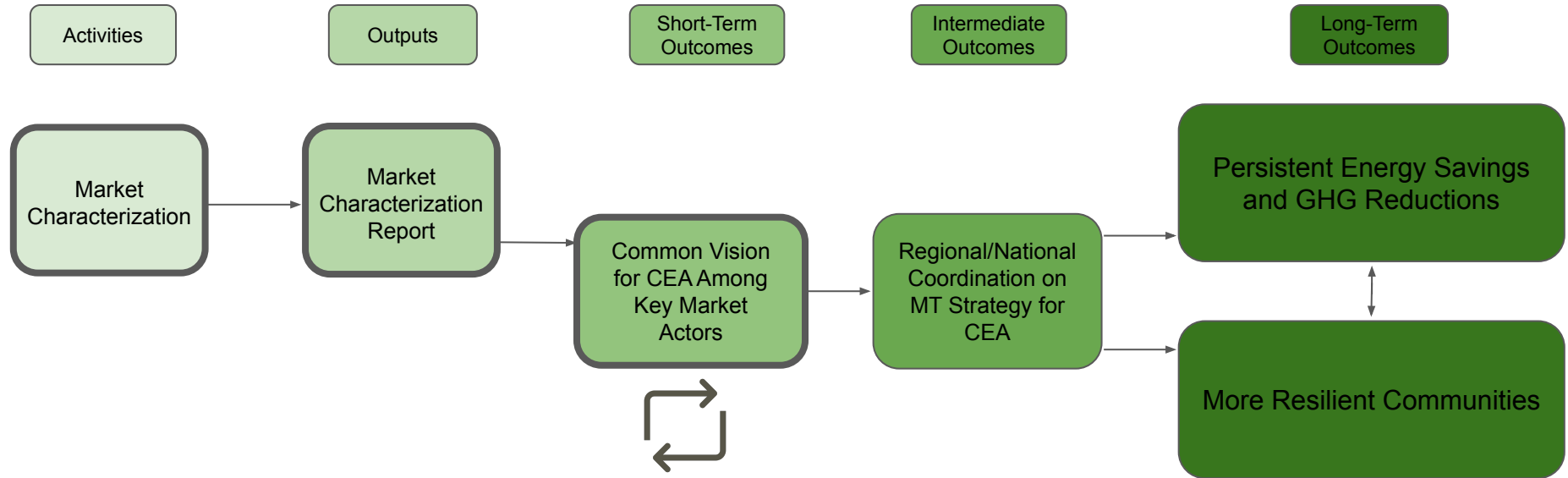
1. **Describe the supply chain**, key market actors, barriers to energy efficiency, and the best leverage points for market interventions,
2. **Describe the energy sources** used by producers (including on-site renewable energy, microgrids, and back-up generation),
3. **Describe the energy and non-energy benefits** realized through implementation of efficiency projects,
4. **Identify key market baselines** to be used in evaluating the impact of the market transformation initiative over time.



Logic Model for Data-Driven Market Transformation for CEA



Market Characterization Process





SECTION 04

FINDINGS & RECOMMENDATIONS

Key Findings

- CEA Supply Chain
- Key Market Actors
- Barriers to Energy Efficiency
- Market Interventions
- Energy Sources for and Energy Use of CEA Facilities
- Energy & Non-Energy Benefits of Efficiency
- Key Market Baselines



Supply Chain: Producers

Producer Categories

- Indoor - Vertical
- Greenhouse
 - Traditional
 - Advanced

Motivators for Growing in Controlled Environments

- Extreme weather, droughts & fires
- Pests & pesticides
- Higher product quality
- Proximity to markets
- Space and water efficiency
- Crop resilience
- Environmental control

Table 5: Canopy Area of U.S. CEA Facilities

<i>Facility Type</i>	<i>Minimum Canopy Area (square feet)</i>	<i>Median Canopy Area (square feet)</i>	<i>Maximum Canopy Area (square feet)</i>
Greenhouse	13,500	348,000	5,000,000
Indoor	500 (research chamber) 5,000 (production)	60,000	280,000

Supply Chain: Producers

Crop Categories*

- Vine Crops
 - Tomatoes, cucumbers
- Vegetables and Herbs
 - Peppers
 - Microgreens
- Floriculture
 - Nursery
 - Bedding crops
- Mushrooms
- Berries

A selection of crops grown indoors



Greens
leafy greens,
lettuce, spinach



Hops



Insects



Strawberries



Vine Crops
tomatoes, peppers,
cucumbers, eggplants



Flowers
perennials, annuals,
ornamentals



**Microgreens/
herbs**



**Vegetable
Transplants**



Fruits



Cannabis



Commodities
corn, wheat



Other
poultry, forestry
seedlings, algae



Other Vegetables
tubers,
mushrooms

*Crops are listed in order of priority. Priority has been initially determined using intensity of horticultural lighting system application as a proxy for energy intensity and will be adjusted as benchmarks for energy intensity present themselves in PowerScore for CEA crop categories.

Supply Chain: Technology & Vendors

CEA Technology Market Growth & Vendor Influence

Projected Growth of CEA Technologies

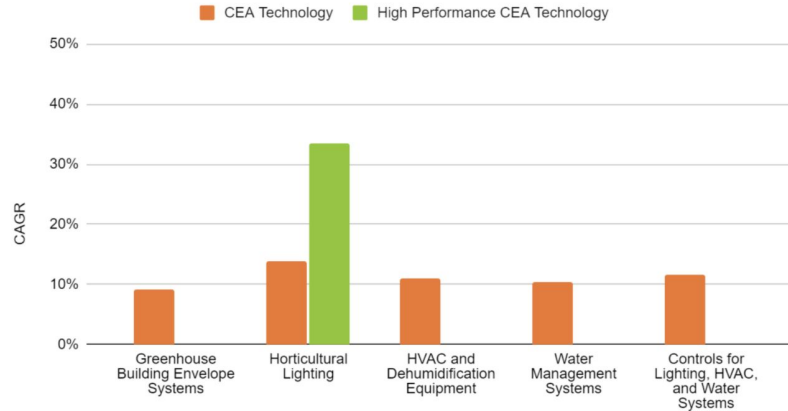


Table 7: Influencers Affecting CEA Technology Purchasing Decisions

Technology Type	Influencer: CEA Facility Staff	Influencer: Technology Manufacturers	Influencer: Manufacturer Sales Representatives	Influencer: Technology Distributors
Horticultural Lighting		X	X	X
HVAC	X	X		
Water Management		X		X
Controls & Automation		X	X	X

Supply Chain: Design & Construction Professionals

CEA Project Teams

- Architects
- Mechanical and electrical engineers
- Lighting designers
- Commissioning agents
- Energy consultants
- Construction management professionals
- Systems integrators
- Construction contractors (HVAC, lighting, and controls contractors)

D&C professionals have varying influence on purchasing by project type: retrofit, new construction, energy infrastructure



Key Market Actors

Consumers

Energy Suppliers

Efficiency Programs

Investors and Financial Institutions

Industry Organizations

State Governments

Research & Educational Institutions





Key Market Actors: Consumers

Consumers Drive Retail for Sustainable Food

- 2006-2015 national market demand for local food expanded from \$1B to \$7B
- 40% of North American consumers are 'frontrunners'
 - Deeply committed to sustainability and aware of their own impact
- Additional 30% are 'followers'
 - Willing to make sustainable food and beverage choices but looking to companies and public institutions to take the lead





Key Market Actors: Energy Suppliers

Energy Prices Influence CEA Facility Energy Choice

Electricity is mission-critical

- Natural gas and propane are common fuels for space heating
- Prices for utility-supplied energy may influence producers to choose alternative fuels

Table 8: Average Commercial and Industrial Energy Prices, 2021

Fuel	Sector	National Average	Lowest (State)	Highest (State)*
Electricity (\$/kWh)	Commercial	\$0.11	\$0.734 (NV)	\$0.1708 (CA)
	Industrial	\$0.0715	\$0.490 (NV)	\$0.1634 (RI)
Natural gas (\$/ccf)	Commercial	\$7.81	\$5.58 (ND)	\$12.18 (RI)
	Industrial	\$5.07	\$3.00 (WV)	\$10.29 (MA)
Propane (\$/gallon)	Wholesale	\$0.894 to \$1.474	NA	NA



Key Market Actors: Efficiency Programs

Reduce First Cost of Efficiency & Operational Expenses

- Deliver cost-effective energy savings while relieving energy supply constraints and achieving government goals for energy use and emissions reductions
- Program offerings include technical assistance and financial incentives for energy efficiency projects
- Programs have expanded in recent years to include lighting and HVAC measures in indoor facilities

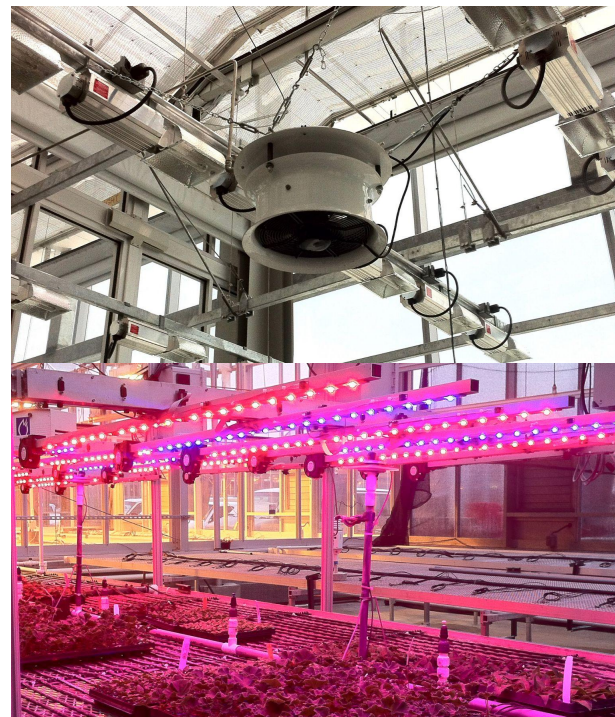


Key Market Actors: Investors and Financial Institutions



Investors Drive Technology Choices

- Efficient technologies frequently increase capital expenditures and may result in longer returns on investment, making them less attractive to investors with shorter-term horizons
- This is particularly true in cases where utility incentives are not as available
- Bundling efficiency upgrades so their total package meets ROI targets is one example of how to overcome these hurdles



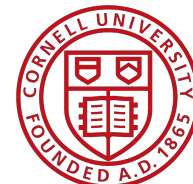
Key Market Actors: Industry Organizations, Research & Educational Institutions

Standards Enable Third-Party Certification

- Bring together range of market actors
- Establish test methods and standards
- Enable defensible verification of savings
- Establish codes and standards

Research Institutions Further Innovation

- USDA extensions provide education and training to bring knowledge gained through research and bring it directly to the people to create positive change

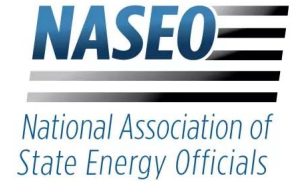


Key Market Actors: State Governments



Influence:

- Establish policies, codes, and standards to achieve energy savings, carbon emissions reductions, and economic development goals
- Energy codes applying to CEA are in development in states like California
- Several national associations represent the interests of these state agencies by facilitating peer learning, sharing resources, and offering opportunities for collaboration



Energy Sources for and Energy Use of CEA Facilities

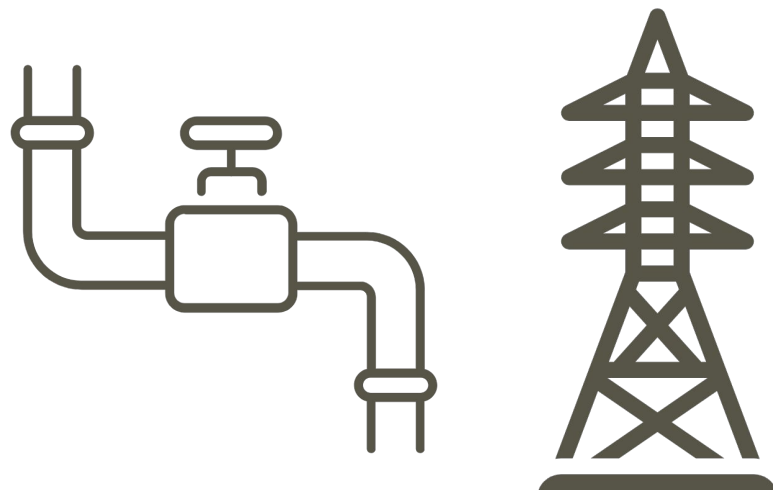
Energy Source Depends on Facility Type & Location

Distributed Energy Resources:

- Backup Generation
- Microgrids
- On-Site Renewable Energy

Key Project Outcome: Establish Baselines for KPIs like Energy Use Intensity

**Benchmarking to validate emerging industry data like electricity use intensity
40 kWh to 150 kWh per square foot**



Energy & Non Energy Benefits of Energy Efficiency Projects

All Efficiency Measures Offer Business Benefits

- Reduced operational expenses
- Lower labor costs
- Improved safety and reduced risk
- Reduced maintenance
- Higher biomass yield
- Improved quality expressions
- Operational approaches like vertical racking
- Interactive effects on other equipment
- Increased facility resilience

Energy Savings Potential by Measure

<i>Energy Savings Measure</i>	<i>Energy Savings Potential</i>
Greenhouse Envelope Systems	5 - 50%
LED Horticultural Lighting	30 - 40%
High Performance HVAC Systems	20 - 30%
Integrated Controls Systems	15 - 30%

Barriers to Energy Efficiency

Lack of Understanding, Trust, & Connections

- Connections can help reduce the cost of capital, increase access to education, and offer technical and financial assistance

Barriers specific to emerging technologies:

- Affect new construction and retrofit projects differently
- May require challenging production shutdowns
- Can suffer from low producer awareness and trust
- May receive less energy efficiency program support

Table 10: Rating of Barriers to Energy Efficiency

Barrier	Rating
Upfront costs	14
Access to capital and financing	9
General lack of knowledge of efficient technologies	8
Skepticism and lack of trust in product performance	8
Lack of executive support for trying something new	4
Not enough cultivator training on how to effectively use technologies	3

Leverage Points for Market Intervention

Six Opportunities for Intervention

1. Knowledge and understanding
2. Visibility
3. Financial influence
4. Marketing
5. Power costs
6. Greenhouses

Table 11: Operational Challenge Rankings for CEA Producers

Challenge	Rank
Keeping operating costs down	1
Predictability/stability of operating costs	3
Sales	4
Predictability of plant performance	4
Managing farm labor	4
Food safety or regulatory compliance	5

Measuring Project Success: Key Market Baselines

Quantitative Impacts

- PowerScore KPIs on efficiency and productivity
- KPIs of key market actors

Actions of Partners

- Adoption of different technologies
- Facility-level efficiency metrics
- Number of dedicated CEA utility programs

Qualitative Impacts

- Events held
- Key market actors reached
- Case studies with producers
- Attitudes toward high performance technologies
- Trainings completed per CEA professional
- Utilities engaged

Conclusions

- Market Segments: greenhouses and indoor farms
- Greens are the primary food crop produced by both
- The range of facility canopy area is wide and varies by market segment and facility infrastructure
- The energy sources used by producers are diverse and dependent on facility type and location
- The energy and non-energy benefits of efficiency projects can be substantial and both are valued by CEA producers
- However, the financial challenges of efficiency projects and technology-specific barriers remain for both segments of CEA producers





SECTION 01

NEXT STEP: MARKET TRANSFORMATION

Market Transformation Recommendations

1. Benchmark a range of production environments to enable development of energy use baselines.
2. Promote the benefits of energy efficiency in ways that are compelling to producers.
3. Target producers effectively based on cultivation approach, geography, power supply costs and size/scale of operation.
4. Leverage key market actors to develop coordinated producer support systems.



Producer Benchmarking Underway

Pilot producer benchmarking nearly complete

Case studies soon

Additional producers being recruited



United States Department of Agriculture

Natural Resources Conservation Service



CEA Best Practices Guides Coming in 2022



FOR PRODUCERS:

- Facility Design & Construction
- Lighting
- HVAC
- Irrigation & Water Reuse
- Controls & Automation

FOR KEY MARKET ACTORS:

- Utility Program Design & Market Engagement
- Policy & Energy Codes

Subject Matter Expert Working Group Members Include...





SECTION 05

Q & A



RESOURCE
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Thank you!

SEND US A MESSAGE OR VISIT US AT
www.ResourceInnovation.org

Derek@ResourceInnovation.org
Gretchen@ResourceInnovation.org
Carmen@ResourceInnovation.org

