RESOURCE INNOVATION INSTITUTE

USDA CEA

MARKET TRANSFORMATION STRATEGY

Data-Driven Market Transformation for Efficient, Sustainable CEA

December 2021

USDA United States Department of Agriculture

Natural Resources Conservation Service

CEA Market Transformation Strategy

Overview

- About RII
- USDA Funded Project: Data-Driven Efficient CEA
- Market Characterization / Recommendations
- Market Transformation

Market Intervention Strategies

- Benchmarking
- Promoting Efficiency
- Coordinating Producer Support Systems

Targeting Producers for Intervention

Implementation Plan

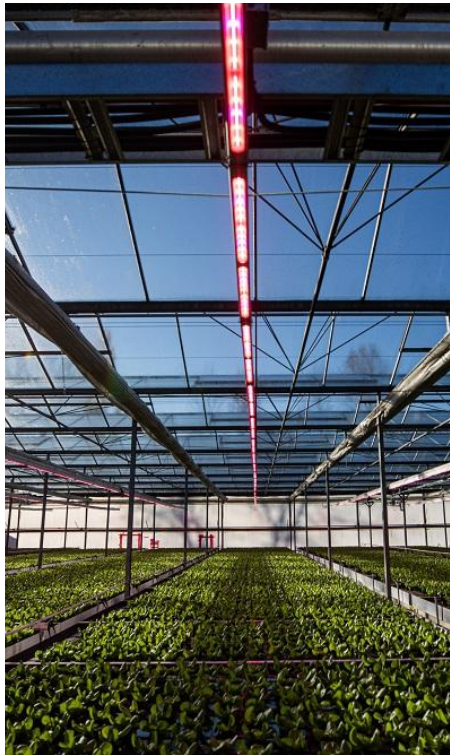
SECTION 01

OVERVIEW

ABOUT US

About RII

- 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 late 2020, awarded three-year grant from USDA to develop KPIs, best practices, standards and a facility performance rating system for CEA



ABOUT US

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

- Education & Training
- Policies
- Utility Programs

Celebrate

Leadership Recognition

- Case Studies
- ESG Support
- Certification

ABOUT US

Technical Advisory Council

Multi-disciplinary Working Groups aggregate knowledge to support producers and other stakeholders with objective and peer-reviewed data and curriculum on benchmarking resource efficiency

- **Guide** development of standards
- **Shape** tools and resources to support best practices
- **Advocate** for informed policies, incentives and regulations

ABOUT US

Peer-Reviewed Publications

Best Practices Guides
for Producers

Best Practices Guides
for Governments and Utilities

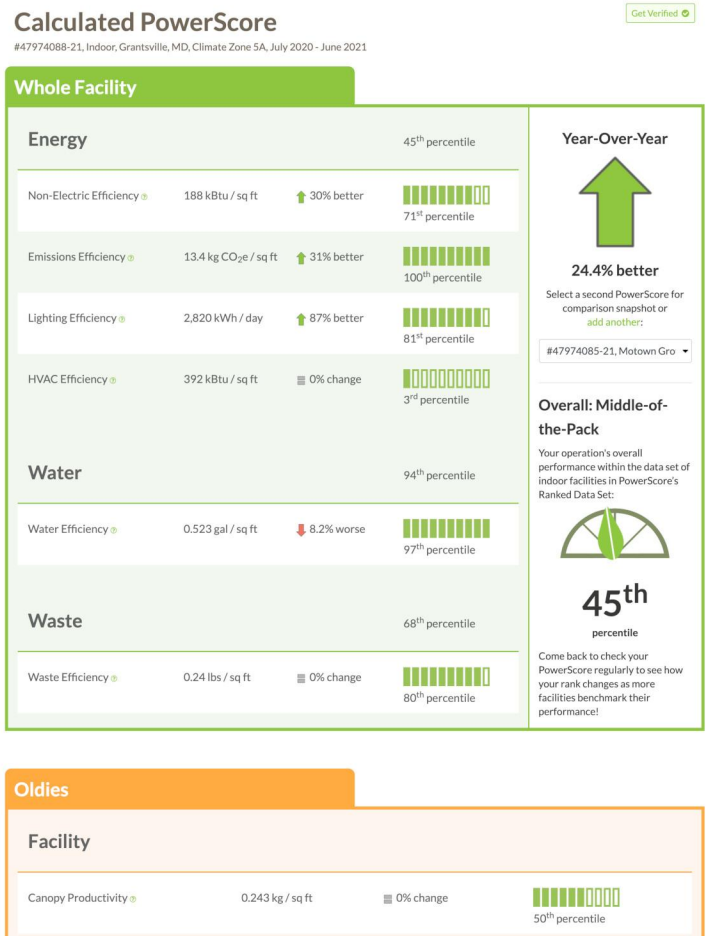
Industry Reports
on Resource Usage

PowerScore

ABOUT US

Specialized Benchmarking Platform

- **Facility performance** benchmarks aligned with industry-standard KPIs on energy, water & emissions
- **Efficiency plans** to guide continuous improvement of KPIs
- **Guidance on** how to maximize incentives and support from utilities and governments
- **Portfolio** audits and reports to compare efficiency and productivity of cultivation assets for ESG reporting and investor stakeholders
- **Thought leadership** opportunities to be featured in case studies and conference presentations



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ACEEE American Council for an Energy-Efficient Economy

Data-Driven Market Transformation for Efficient, Sustainable CEA

Launched 2021

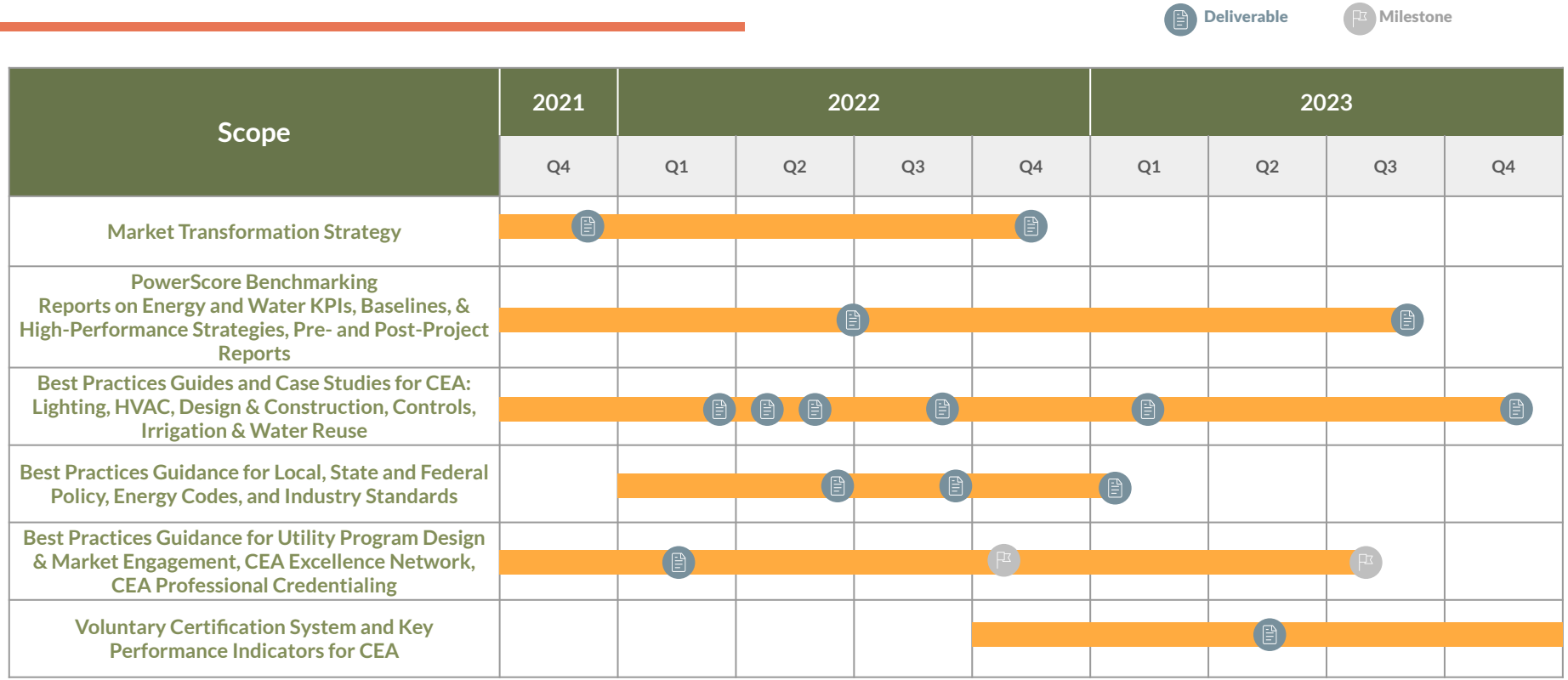
Funded through 2023 by:

USDA United States Department of Agriculture

Natural Resources Conservation Service

USDA PROJECT

Grant Objectives & Timeline



USDA PROJECT

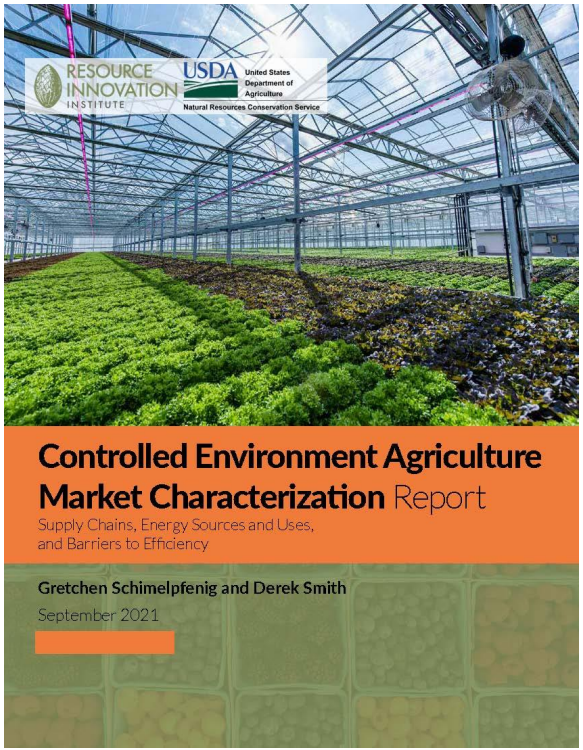
CEA Market Characterization Report

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



USDA PROJECT

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.

USDA PROJECT

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. Leverage key market actors to develop coordinated producer support systems.

Target producers effectively based on cultivation approach, geography, power supply costs and size/scale of operation.

USDA PROJECT

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.

USDA PROJECT

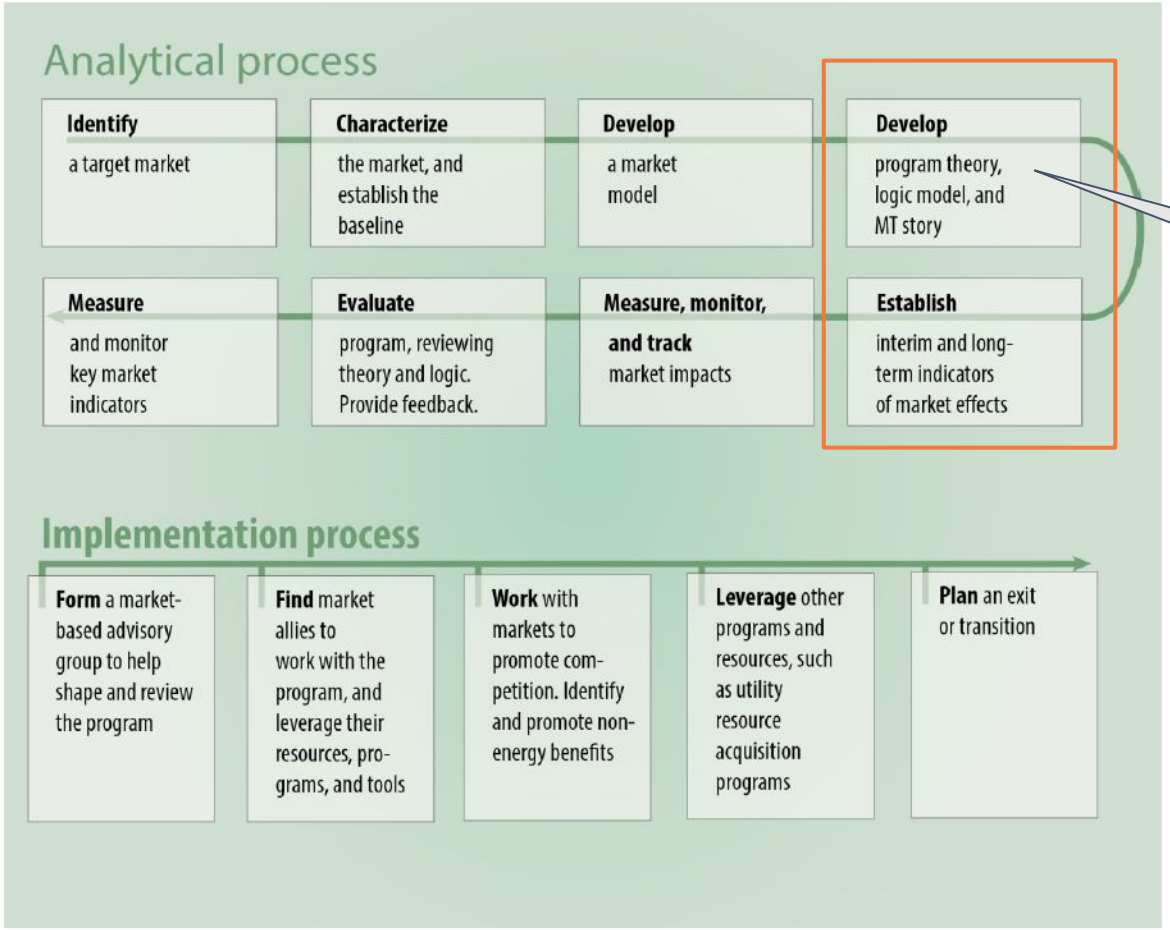
Market Transformation Components

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

In-depth knowledge of the targeted energy efficiency market

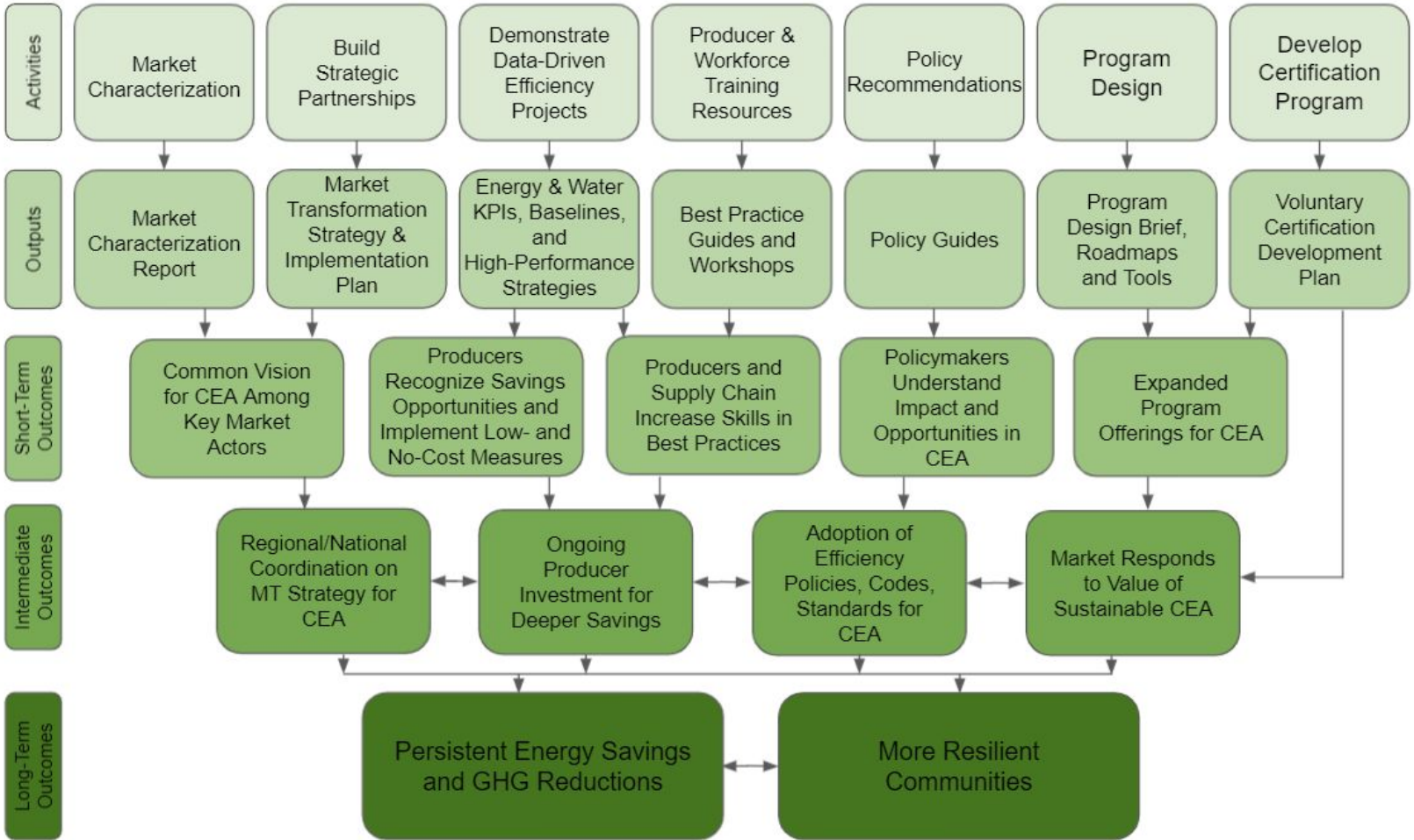
Clearly defined intervention strategy and key leverage points

Policy/regulatory framework supporting the intervention strategy


Analytical process
Identify
a target market
Characterize
the market, and establish the baseline
Develop
a market model
Develop
program theory, logic model, and MT story
Measure
and monitor key market indicators
Evaluate
program, reviewing theory and logic. Provide feedback.
Measure, monitor, and track
market impacts
Establish
interim and long-term indicators of market effects
Implementation process
Form a market-based advisory group to help shape and review the program
Find market allies to work with the program, and leverage their resources, programs, and tools
Work with markets to promote competition. Identify and promote non-energy benefits
Leverage other programs and resources, such as utility resource acquisition programs
Plan an exit or transition

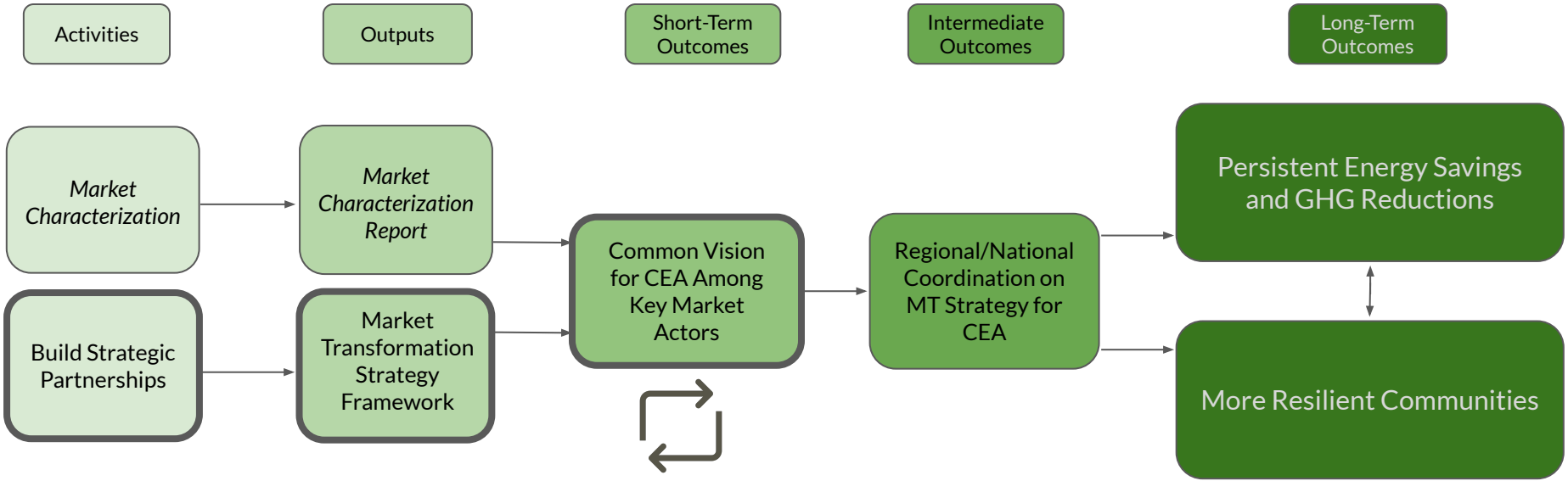
We are here

Logic Model for Data-Driven Market Transformation for CEA



USDA PROJECT

Market Transformation Strategy Framework



SECTION 02

MARKET INTERVENTION STRATEGIES

Market Transformation Pathway

VISION: Sustainable, resource-efficient CEA supported by rigorous data and shared best practices

BARRIERS

Lack of data, baselines, and success stories

Supply chain knowledge, skills, and support

Low grower awareness and demand

High first/capital cost and limited incentives

STRATEGIES

BENCHMARKING

PROMOTING EFFICIENCY

SUPPORTING PRODUCERS

Benchmark diverse set of producers and facilities to establish baselines and key performance indicators

Engage and educate installers and builders to create experts along the supply chain and establish credentialing program

Demonstrate peer success through case studies, educate producers on energy and non-energy benefits

Convene policymakers, utilities, and key market actors to develop coordinated producer support systems and industry standards

STRATEGY #1

BENCHMARKING

STRATEGY #1: BENCHMARKING

Create Facility Performance Snapshots

Confirm Key Performance Indicators for CEA

Quantify performance of CEA facilities using specialized key performance indicators for:

- Efficiency
- Productivity

Establish calculation methodology for KPIs

Understand how KPIs apply to various crops

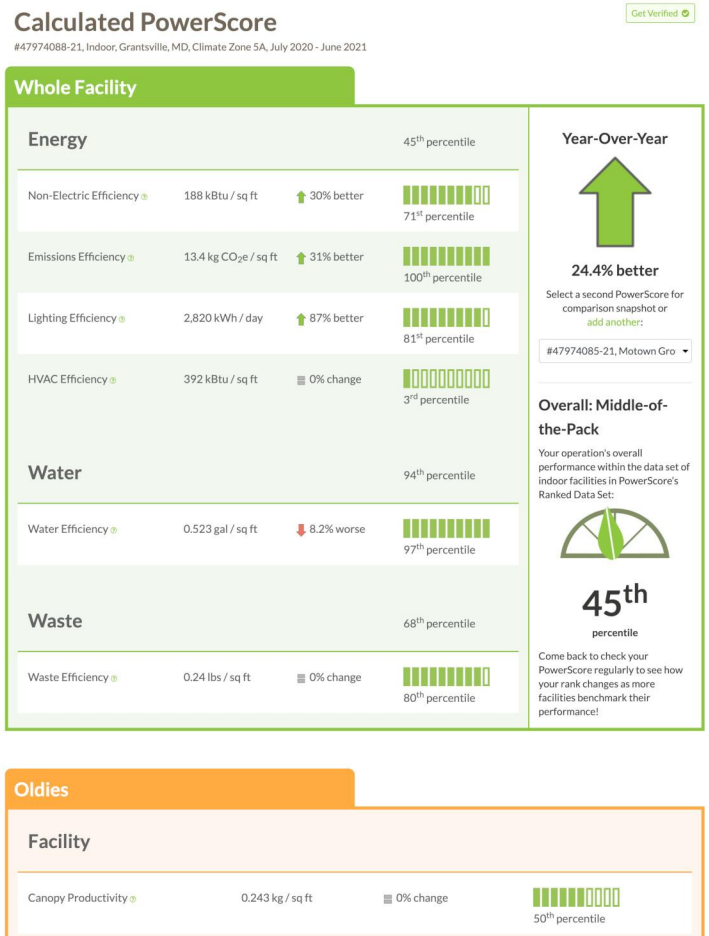


Figure credit: RII, PowerScore

STRATEGY #1: BENCHMARKING

Verify KPIs

Verify Facility Information

Validate data reported by operators, utilities, and building systems to produce accurate ranges of performance

Increase quantity of data read by artificial intelligence

Connect data provider API for direct integration

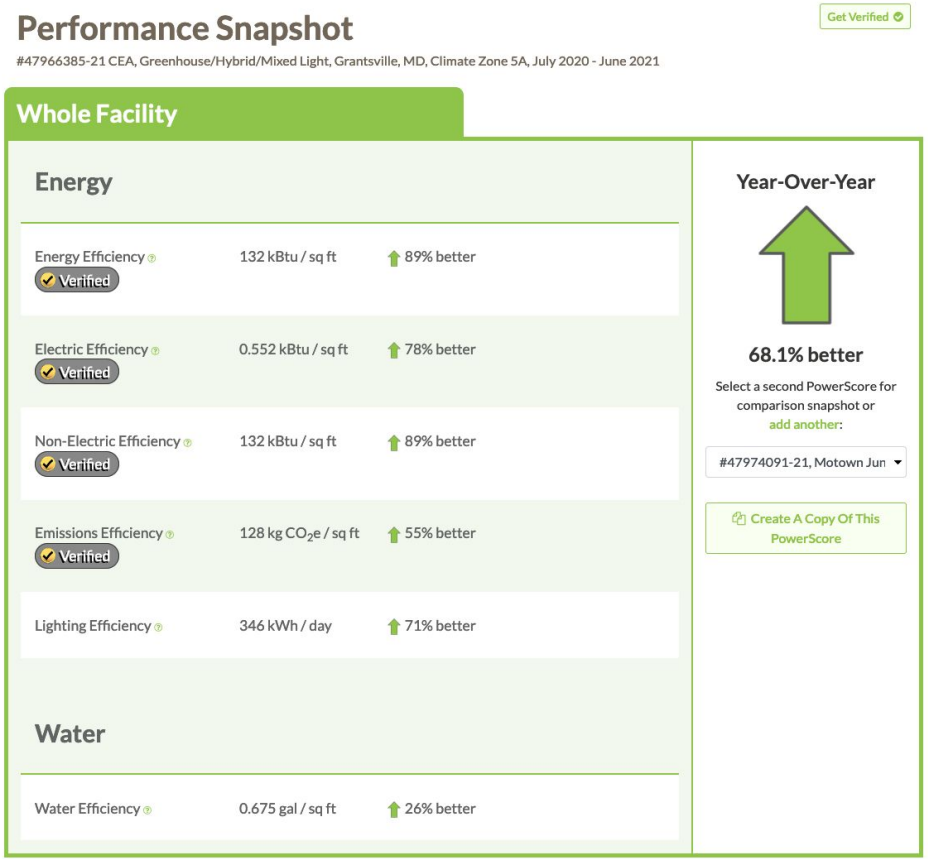


Figure credit: RII, PowerScore

STRATEGY #1: BENCHMARKING

Document Baselines

Capture Market Practices and Performance

Benchmark a range of production environments to enable development of resource use baselines:

- Energy
- Water
- Emissions

Establish baseline methodology

Understand baselines for different facility and crop types

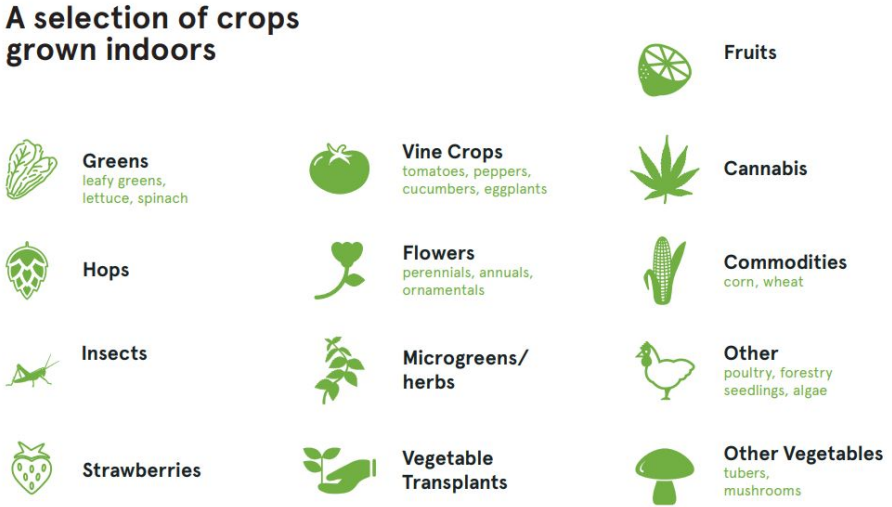


Figure credit: Rhode Island Department of Environmental Management

STRATEGY #2

PROMOTING EFFICIENCY BENEFITS

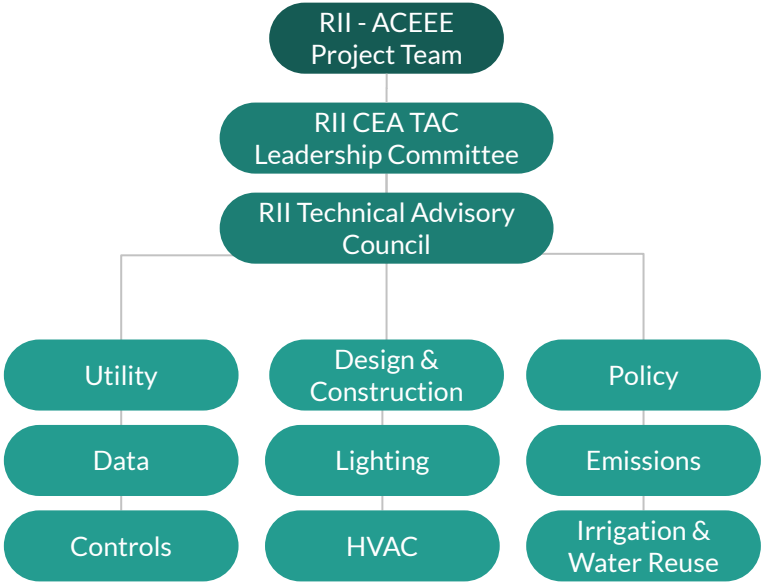
STRATEGY #2: PROMOTING EFFICIENCY BENEFITS

Develop Best Practices Guidance

Promote efficiency benefits in ways that are compelling to producers

New CEA Working Groups:

1. Design & Construction
2. Lighting
3. HVAC
4. Automation & Controls
5. Policy, Codes & Standards
6. Irrigation & Water Reuse



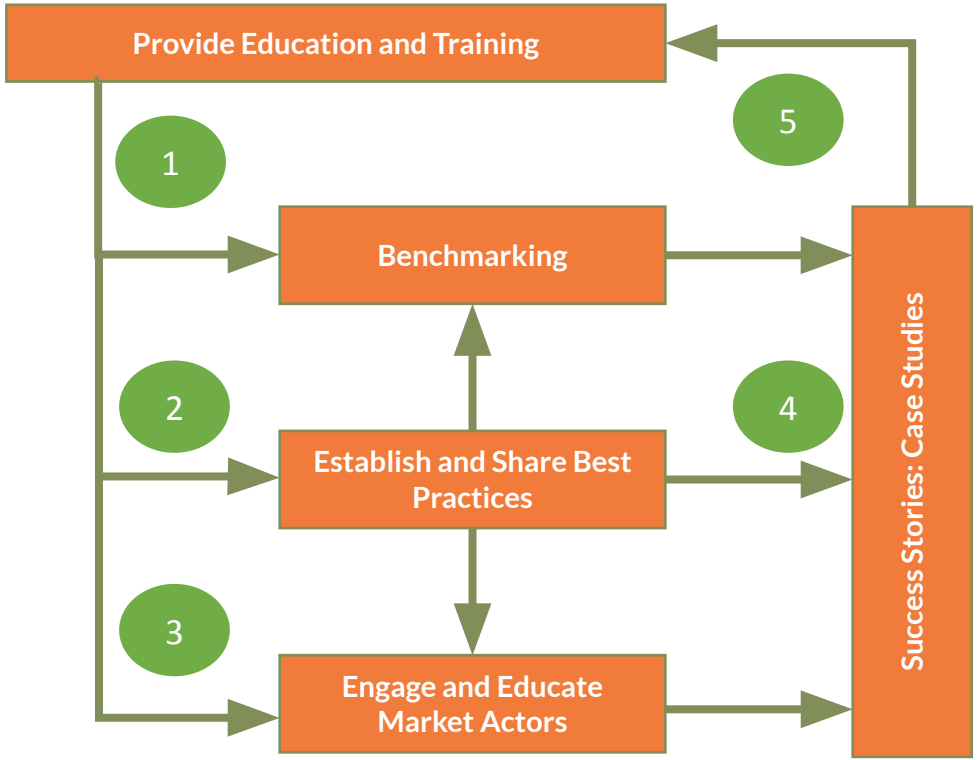
STRATEGY #2: PROMOTING EFFICIENCY BENEFITS

Launch CEA Working Groups

Working Group	Status	Kickoff Month	Collaboration Months	Peer Review Months	Publication Month	Workshop Month
Utility	Active	Sept 2021	Sept - Nov 2021	Nov-Dec 2021	Feb 2022	Mar 2022
Facility Design & Construction	Active	Oct 2021	Oct 2021- Feb 2022	Feb-Mar 2022	May 2022	Jun 2022
Lighting	Active	Nov 2021	Nov 2021 - Feb 2022	Feb 2022	Mar 2022	Apr 2022
HVAC	Recruiting	Dec 2021	Dec 2021 - Mar 2022	Feb 2022	Apr 2022	May 2022
Policy	Recruiting	May 2022	May - Dec 2022	Apr, Aug, Dec 2022	Jun & Sep 2022 Jan 2023	Jul & Oct 2022 Feb 2023
Controls	Planning	Apr 2022	Apr - Jun 2022	Jun 2022	Jul 2022	Aug 2022
Irrigation & Water Reuse	Planning	Aug 2022	Aug - Nov 2022	Jan 2023	Feb 2023	Mar 2023

STRATEGY #2: PROMOTING EFFICIENCY BENEFITS

Build Market Capacity



1. Use **industry benchmarks** to establish high-performance baselines for diverse facilities and crop types.
2. Develop and disseminate peer-reviewed **best practices guides** covering key aspects of resource efficient CEA.
3. Develop and present **workshops, webinars, and in-depth tutorial videos** to engage and educate cultivators, contractors, installers.
4. Produce **case studies** to highlight success stories and demonstrate progress.
5. Host curriculum on **virtual classrooms** to continuously educate producers on energy and non-energy benefits.

STRATEGY #2: PROMOTING EFFICIENCY BENEFITS

Engage and Educate Supply Chain Actors

Establish Credentialing Program

Catalog of CEA best practices guidance for project partners:

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

Credential achieved upon completion of required coursework

Continuing education required to maintain credential

Best Practices Guides

Live Workshops

Case Studies

Virtual Classrooms
for Producers and Project Teams

STRATEGY #3

SUPPORTING PRODUCERS

STRATEGY #3: SUPPORTING PRODUCERS

Leverage Key Market Actors

Energy Suppliers

Efficiency Programs

State Governments

Consumers

Investors & Financial Institutions

Industry Organizations

Educational Institutions

STRATEGY #3: SUPPORTING PRODUCERS

Barriers to Energy Efficiency

Investors & Financial Institutions

Create Coordinated Producer Support Systems

Provide Understanding, Trust, & Connections

- Emerging technologies can suffer from low producer awareness and trust and efficient products have higher upfront costs
- Connections can help reduce the cost of capital, increase access to education, and offer technical and financial assistance

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

STRATEGY #3: SUPPORTING PRODUCERS

Flavors of Efficiency Programs

Efficiency Programs

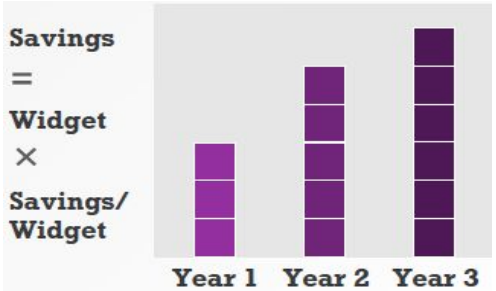
Resource Acquisition

- Achieve near-term savings
- Targeting specific customers
- Incentives in exchange for energy savings

✓ Smaller program scope and scale

✓ Greater level of program control

✓ Simpler evaluation for program administrator and regulators



Market Transformation

- Long-term savings through structural change
- Target customers and supply chain
- Use multiple market interventions

✓ Broad scope of participants and activities

✓ PAs have limited control in a dynamic market

✓ Evaluation is messier and requires longer planning and measurement timeframe

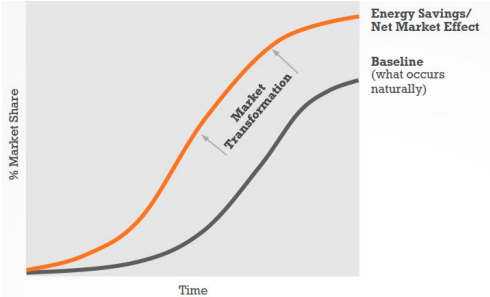


Figure credit: Navigant Consulting. 2019. Energy Efficiency Market Transformation Summit Report. Prepared for ComEd. February. Chicago, IL: Commonwealth Edison

STRATEGY #3: SUPPORTING PRODUCERS

Role of Efficiency Programs in MT

Efficiency Programs

Mobilize the market

- Provide incentives to address cost barriers
- Coordinate with supply chain to increase market availability and access
- Offer training and technical assistance to develop workforce
- Conduct demonstrations to prove technology, build confidence, and address perceived risks
- Leverage national recognition programs

Evaluate, measure, verify savings

- Market baseline: energy performance, equipment types/efficiency
- Indicators of market progress and structural change
  - Increases in stocking/sales; voluntary program recognition
  - Lock-in through codes and standards
- Program attribution: participation, free riders, spillover
- Cumulative energy impact

STRATEGY #3: SUPPORTING PRODUCERS

Incentives for Efficient Technology

Efficiency Programs

Incentives Address First Cost Barriers

Effective programs target incentives to the right market actors to maximize market impact

Example CEA technologies with efficiency incentives:

- Energy screens / shade curtains
- Horticultural light fixtures
- HVAC and dehumidification equipment
- Controls hardware and software for lighting and HVAC systems

STRATEGY #3: SUPPORTING PRODUCERS

CEA Technology Purchasing

Targeting Incentives for CEA Technology

Upstream:

- Strong option for all technology types

Midstream:

- Important for lighting, water management, controls & automation

Downstream:

- HVAC uniquely suited to upstream and downstream

Efficiency Programs

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

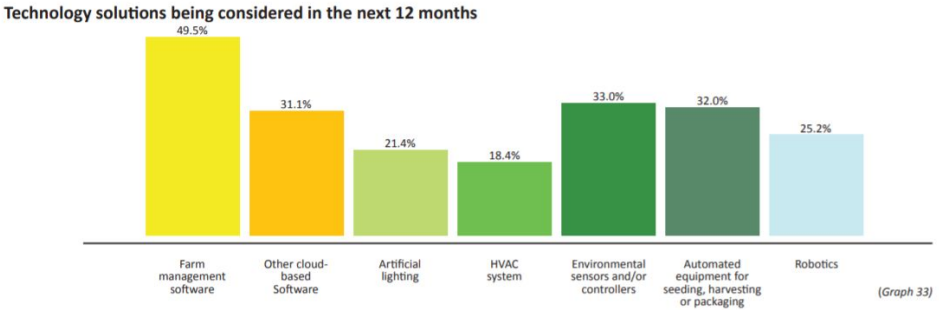


Table credit: RII (top right); Figure credit: WayBeyond (bottom right)

STRATEGY #3: SUPPORTING PRODUCERS

Robust Standards for CEA

Convene Key Market Actors to Develop Standards

Effective industry standards enable:

- Testing of emerging technologies
- Third-party certification of equipment
- Specification of minimum efficiency requirements in regulations and energy codes
- Sharing of industry standard practice and high-performance strategies by educational organizations

Industry Organizations

State Governments

Educational Institutions

SECTION 03

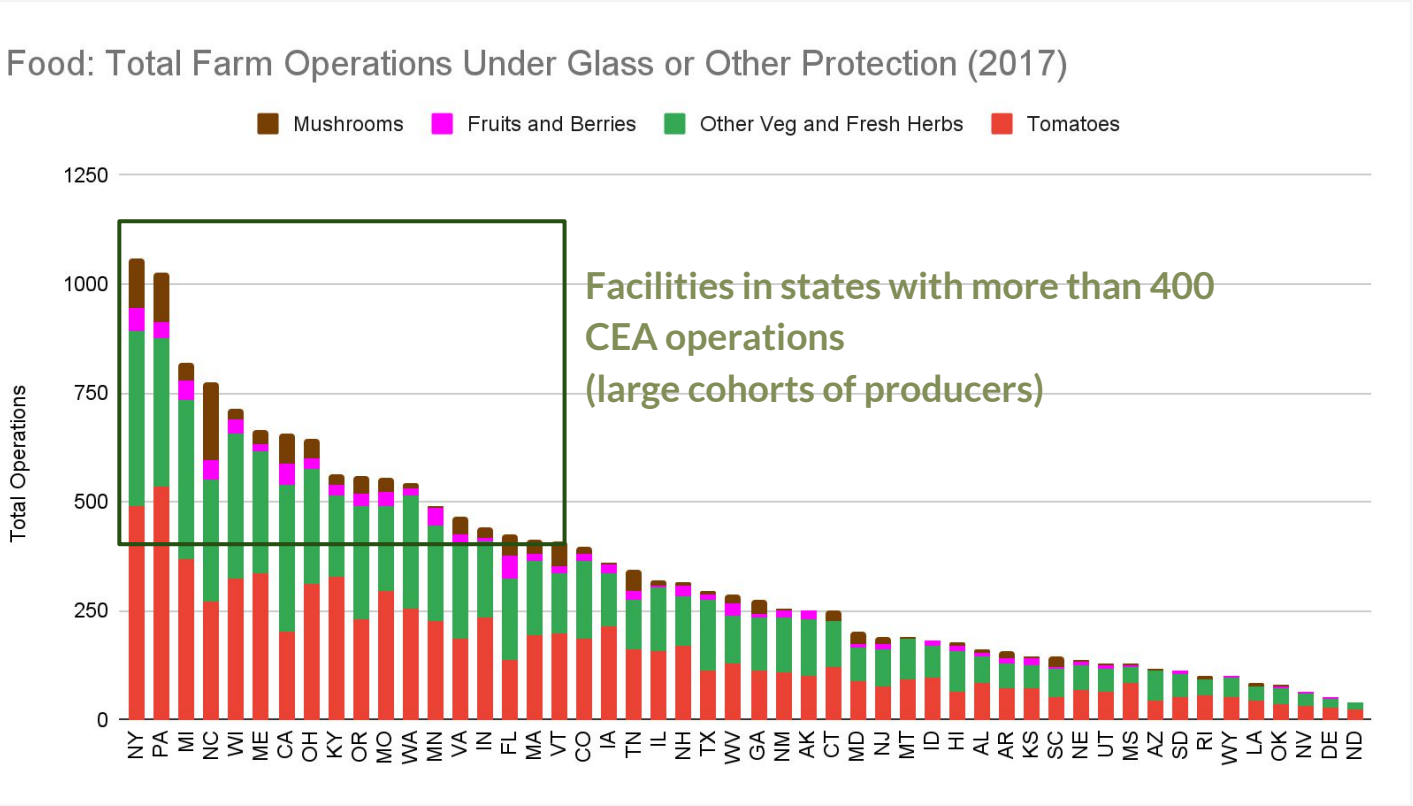
TARGETING PRODUCERS

Targeting Producers: Food State Operations Under Protection

Note: Minimum of $1,000 sales to be counted. States with too few respondents, (D) or -, counted as 0

Categories:

- Family or Individual
- Partnership
- Corporation
- Other
  Estate, trust, prison farm, grazing association, American Indian Reservation

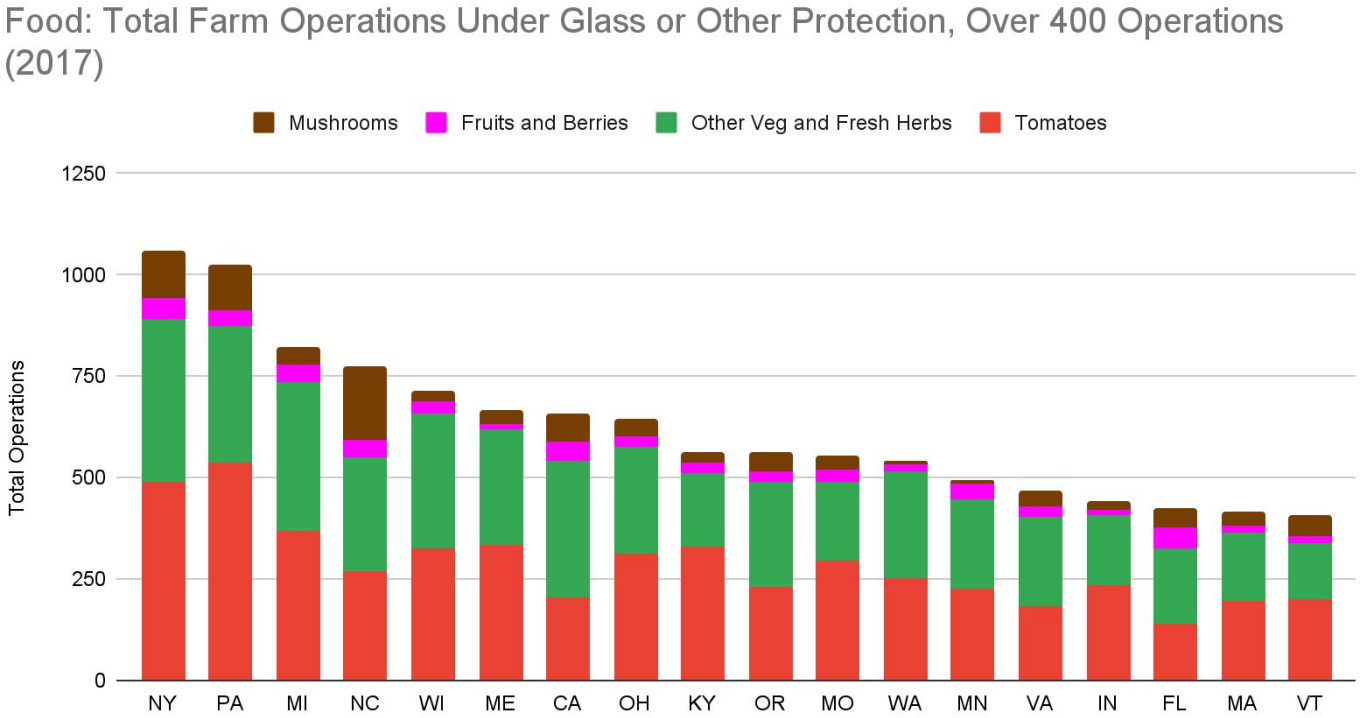


Data credit: USDA, 2019

Targeting Producers: Food State Operations Under Protection

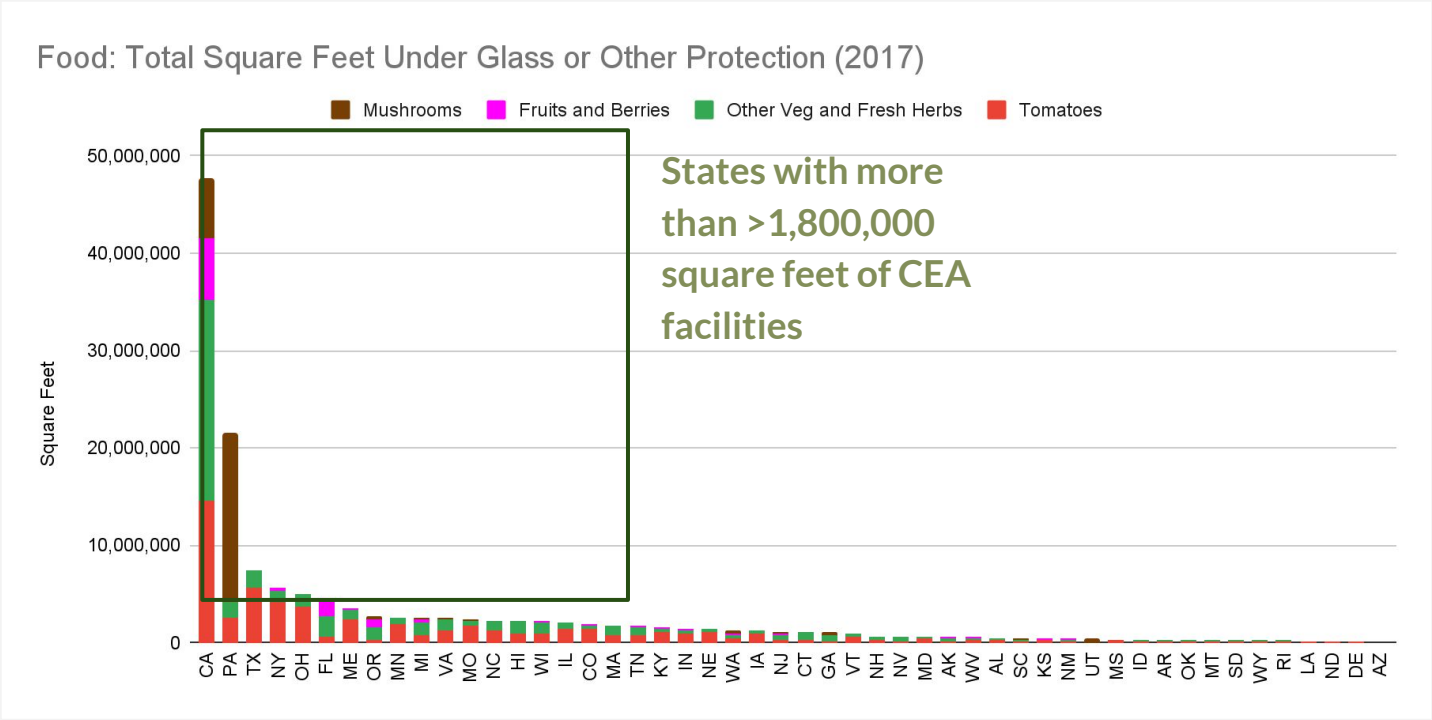
Priority states:

1. NY
2. PA
3. MI
4. NC
5. WI
6. ME
7. CA
8. OH
9. KY
10. OR
11. MO
12. WA
13. MN
14. VA
15. IN
16. FL
17. MA
18. VT



Data credit: USDA, 2019

Targeting Producers: Food Square Feet Under Protection

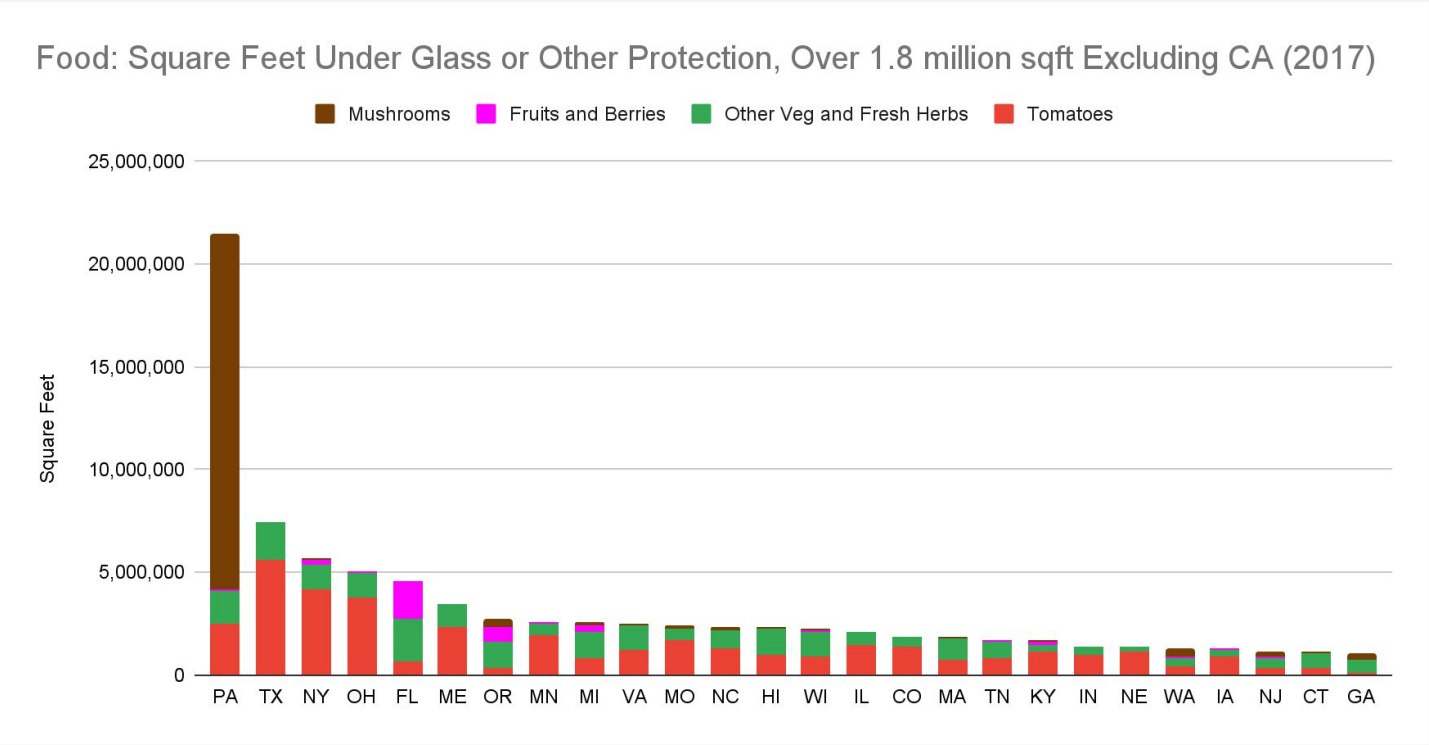


Data credit: USDA, 2019

Targeting Producers: Food Square Feet Under Protection

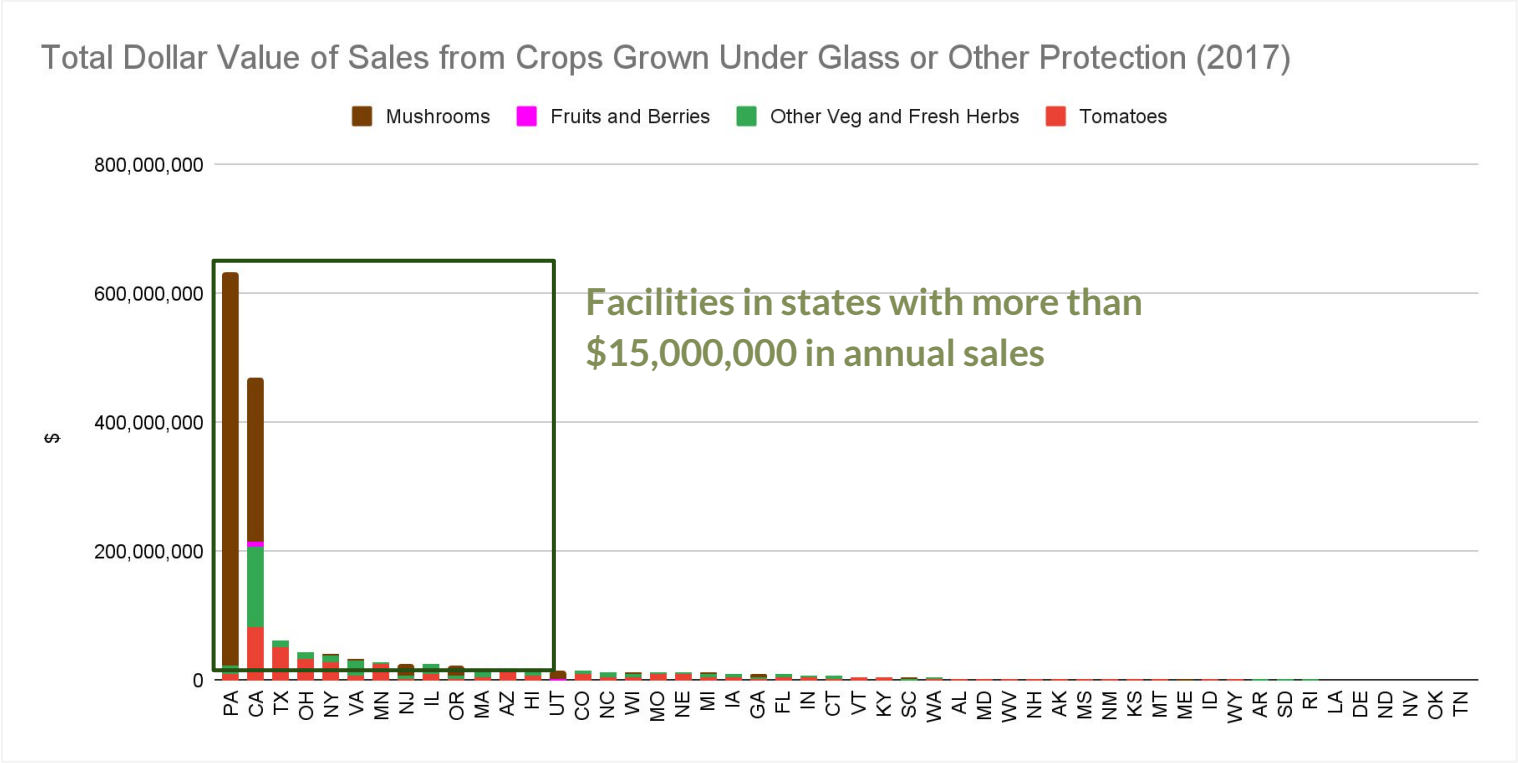
Priority states:

1. **CA**
2. **PA**
3. TX
4. **NY**
5. **OH**
6. FL
7. **ME**
8. **OR**
9. **MN**
10. **MI**
11. **VA**
12. **MO**
13. **NC**
14. HI
15. **WI**
16. IL
17. CO
18. MA



Data credit: USDA, 2019. Note: CA excluded as outlier for data visualization.

Targeting Producers: Food Sales Volume of Operations Under Protection

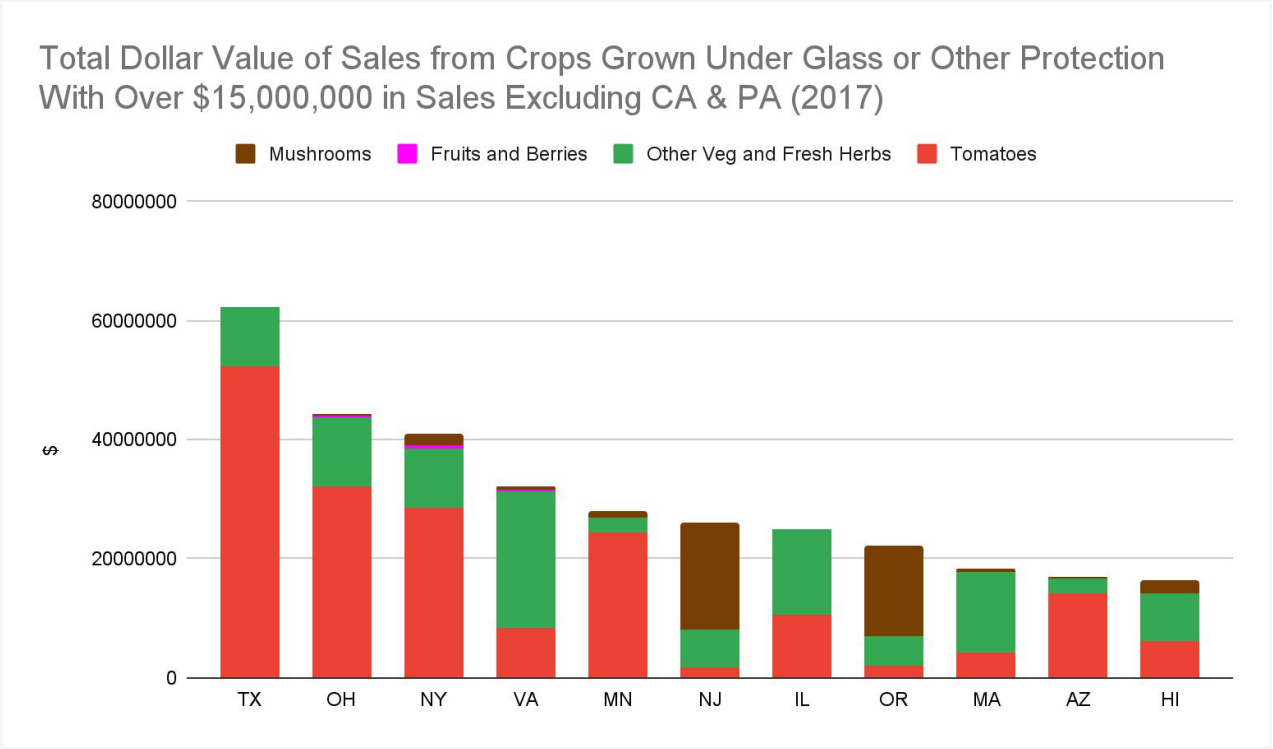


Data credit: USDA, 2019

Targeting Producers: Food Sales Volume of Operations Under Protection

Priority states:

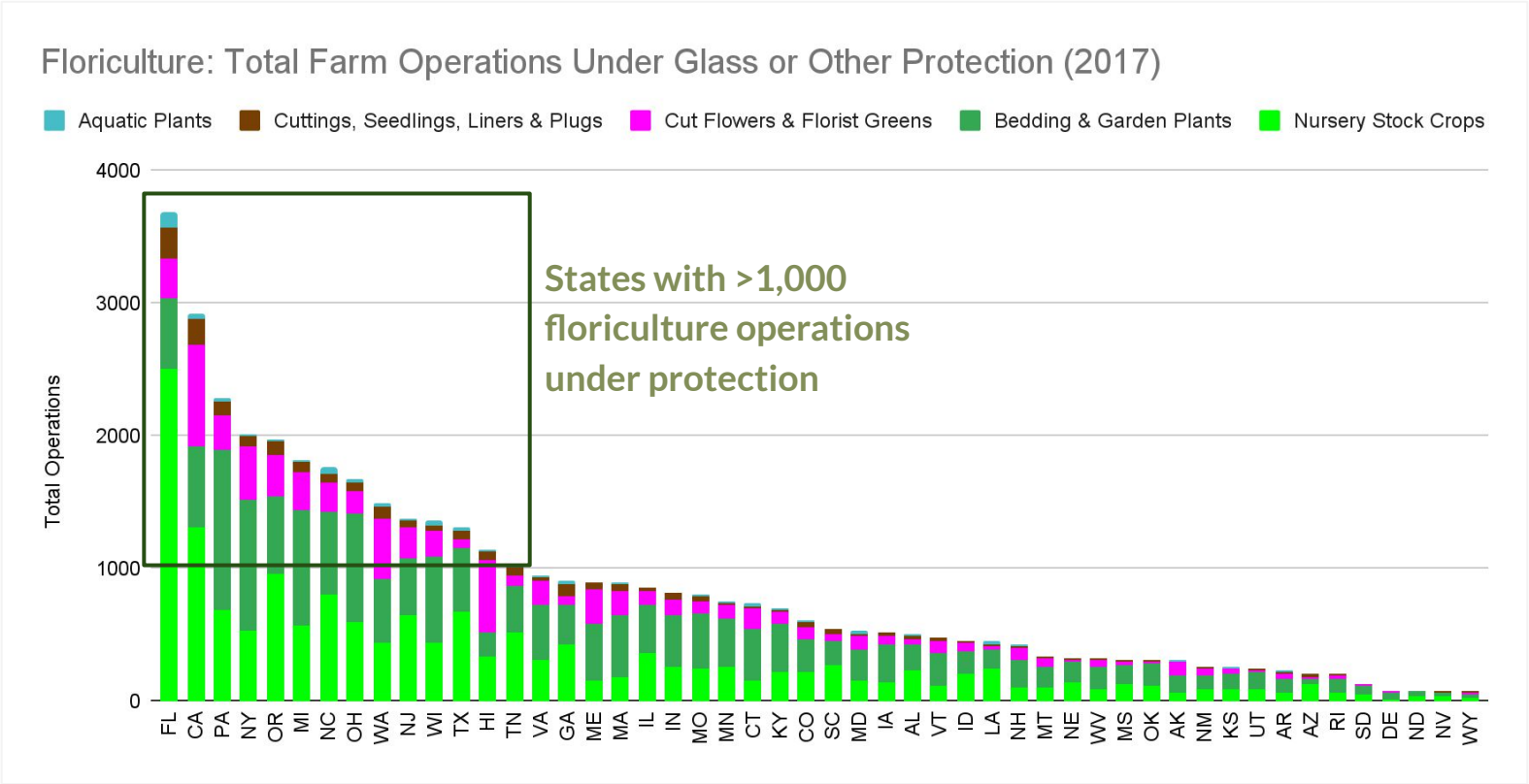
1. PA
2. CA
3. TX
4. OH
5. NY
6. VA
7. MN
8. NJ
9. IL
10. OR
11. MA
12. AZ
13. HI



Data credit: USDA, 2019. Note: PA and CA excluded as outlier for data visualization

[R-048 2019 USDA Ag Census]

Targeting Producers: Floriculture Operations Under Protection

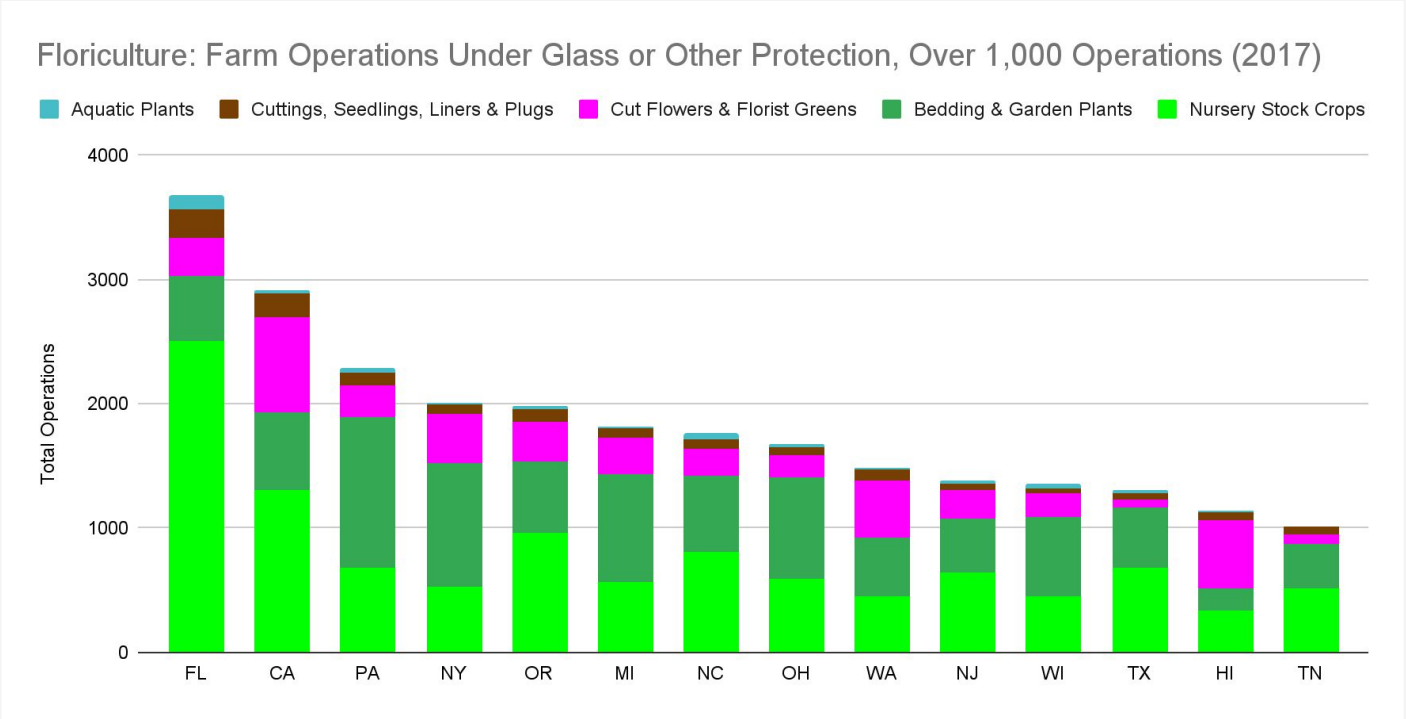


Data credit: USDA, 2019

Targeting Producers: Floriculture Operations Under Protection

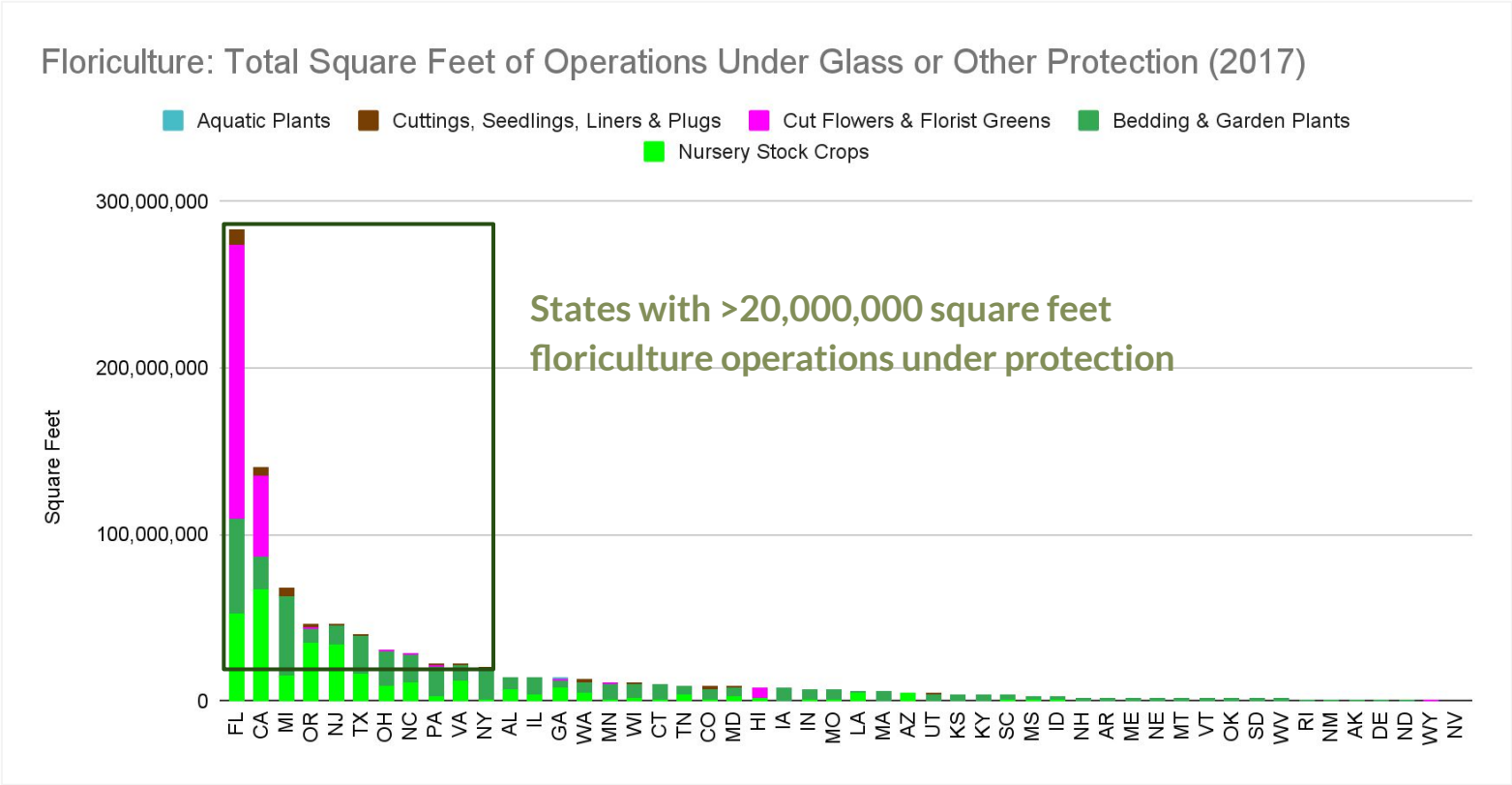
Priority states:

1. FL
2. CA
3. PA
4. NY
5. OR
6. MI
7. NC
8. OH
9. WA
10. NJ
11. WI
12. TX
13. HI
14. TN



Data credit: USDA, 2019

Targeting Producers: Floriculture Square Feet Under Protection



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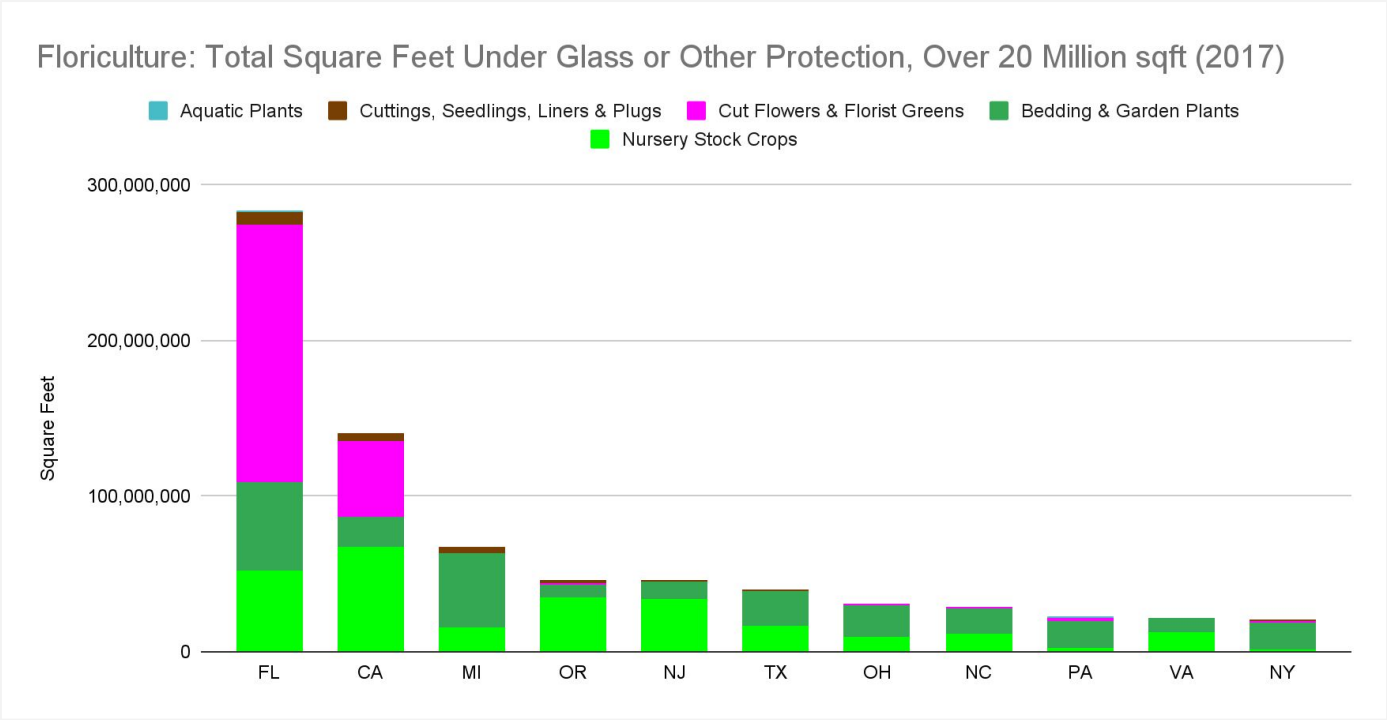
Targeting Producers: Floriculture Square Feet Under Protection

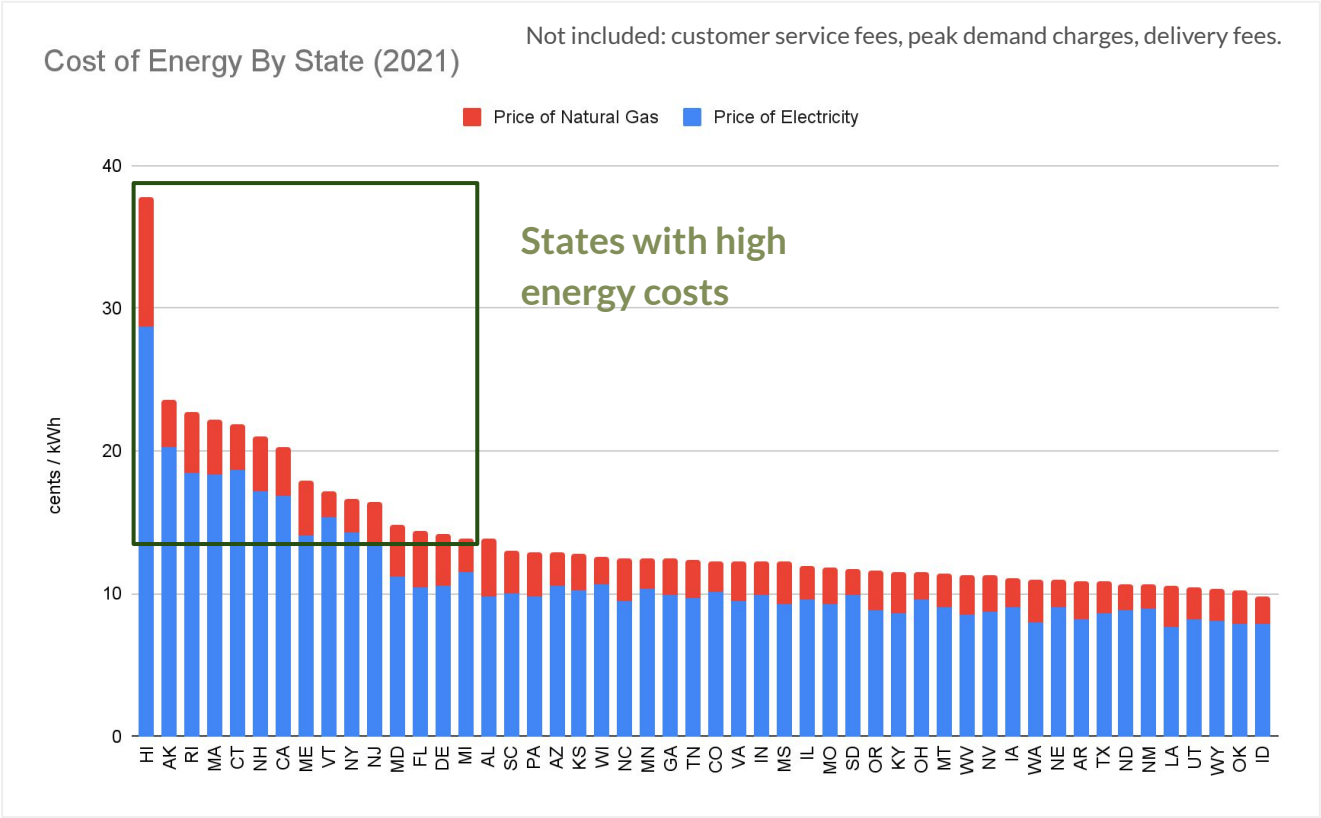
Priority states:

1. FL
2. CA
3. MI
4. OR
5. NJ
6. TX
7. OH
8. NC
9. PA
10. VA
11. NY



Data credit: USDA, 2019

Targeting Producers: Cost of Energy

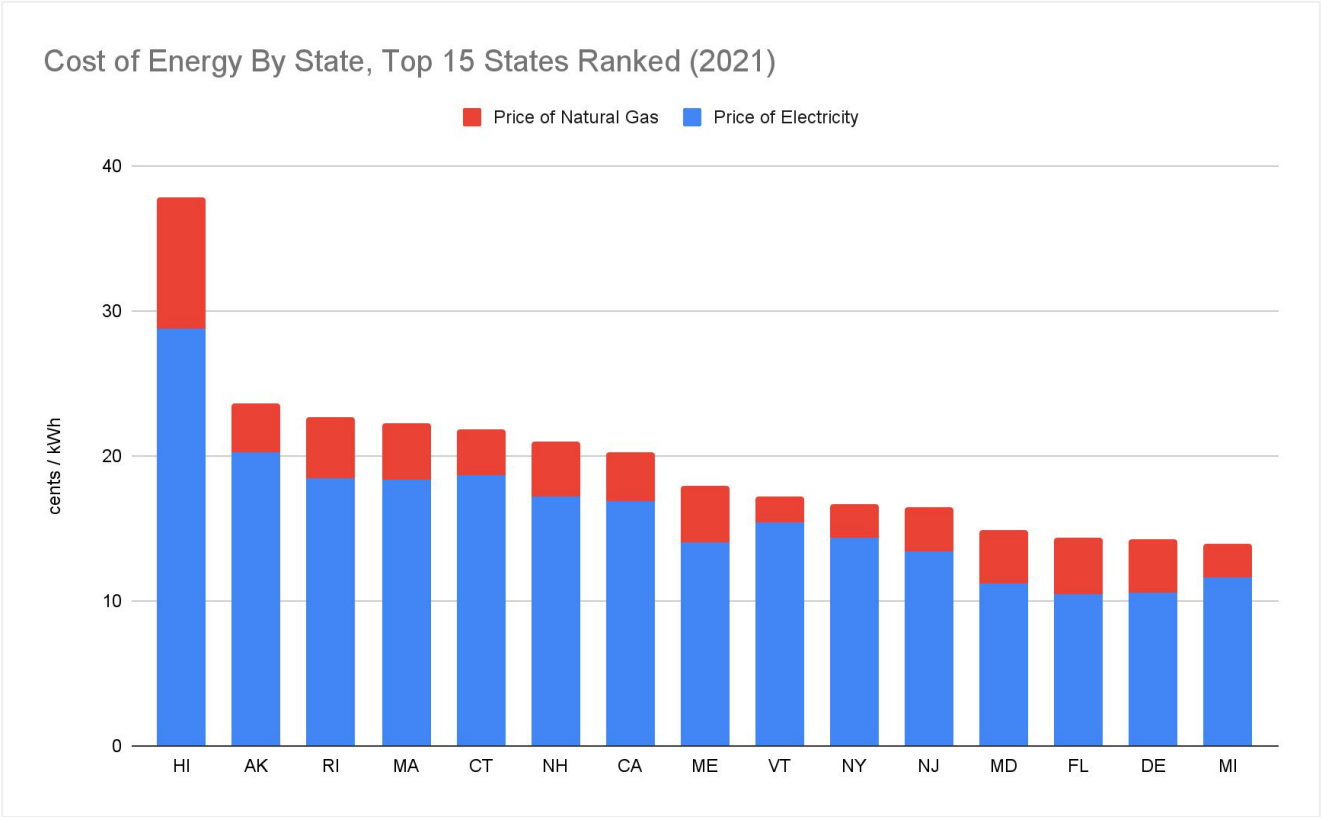


Data credit: EIA, 2021

Targeting Producers: Most Expensive Energy

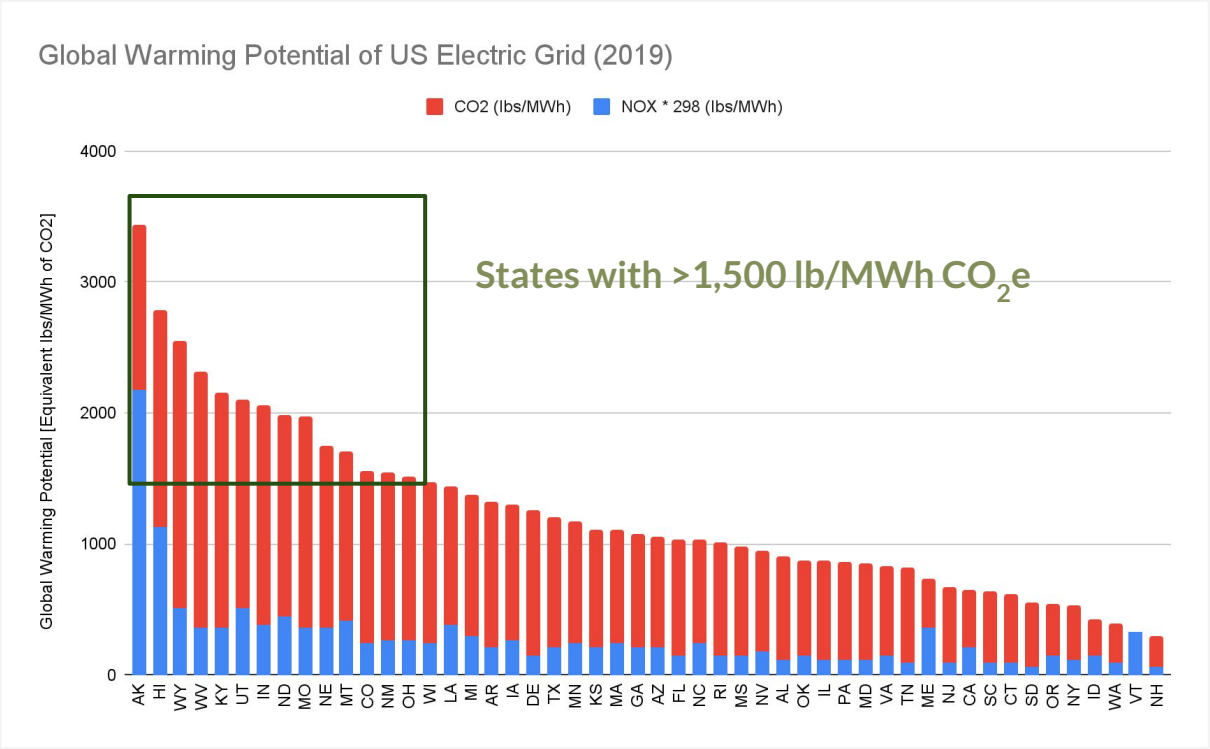
Priority states:

1. ***HI***
2. AK
3. RI
4. **MA**
5. CT
6. NH
7. ***CA***
8. **ME**
9. **VT**
10. ***NY***
11. ***NJ***
12. MD
13. ***FL***
14. DE
15. ***MI***



Data credit: EIA, 2021

Targeting Producers: Greatest GHG Emissions from Electricity

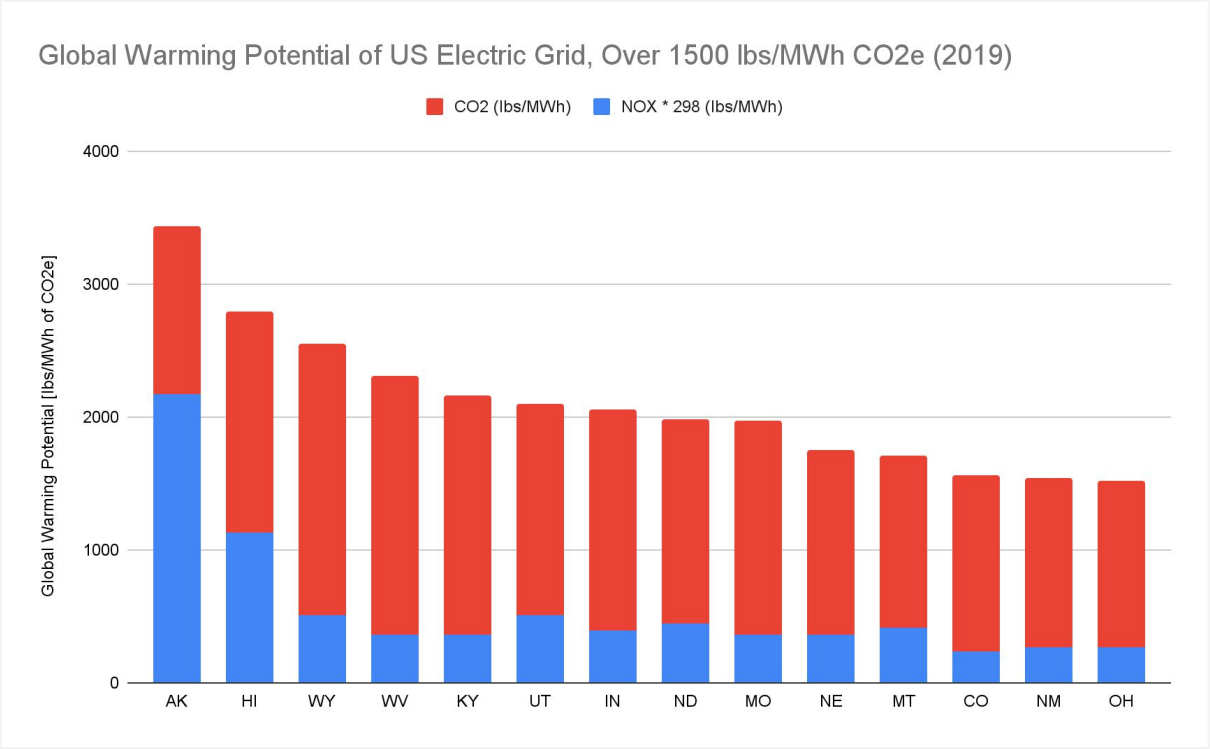


Data credit: EIA, 2019

Targeting Producers: Greatest GHG Emissions from Electricity

Priority states:

1. **AK**
2. ***HI***
3. WY
4. WV
5. **KY**
6. **UT**
7. **IN**
8. ND
9. **MO**
10. NE
11. MT
12. **CO**
13. NM
14. *OH*

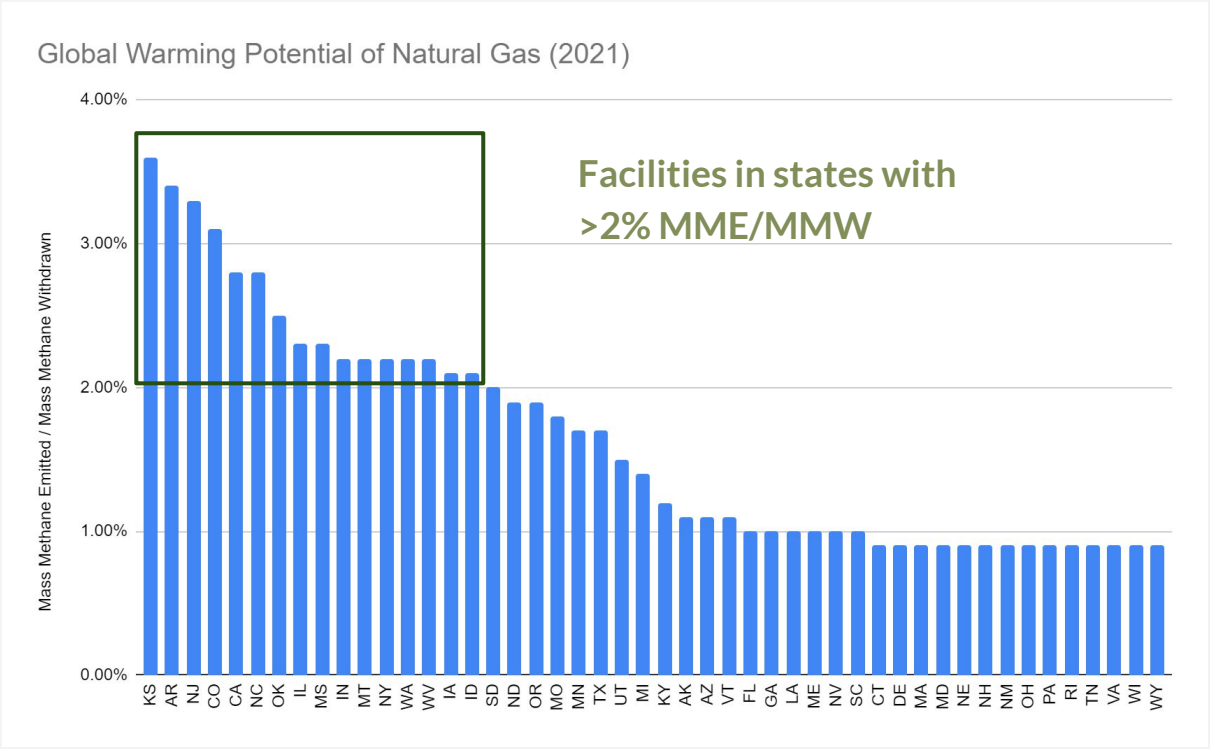


Data credit: EIA, 2019

Targeting Producers: Greatest GHG Emissions from Natural Gas

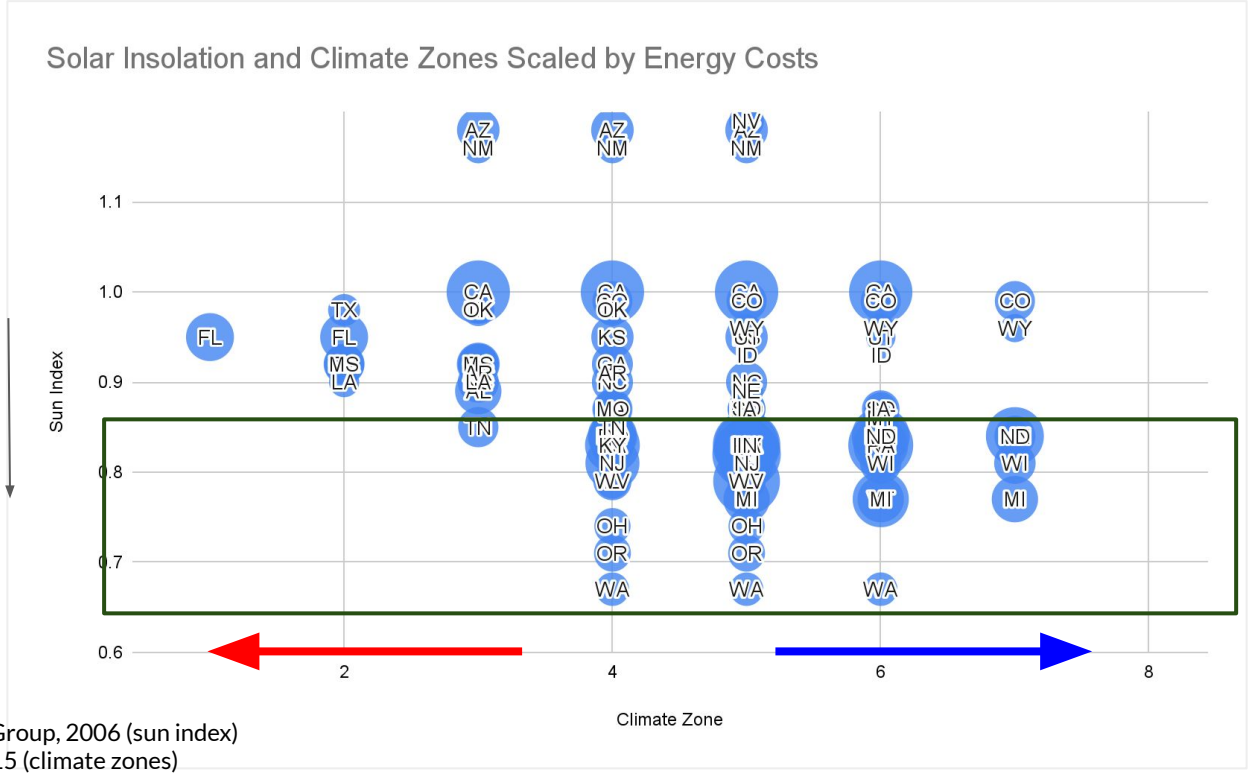
Priority states:

1. KS
2. AR
3. NJ
4. CO
5. CA
6. NC
7. OK
8. IL
9. MS
10. IN
11. MT
12. NY
13. WA
14. WV
15. IA
16. ID



Data credit: Georgia Tech's School of Civil and Environmental Engineering, 2021. AK & HI not included in data source.

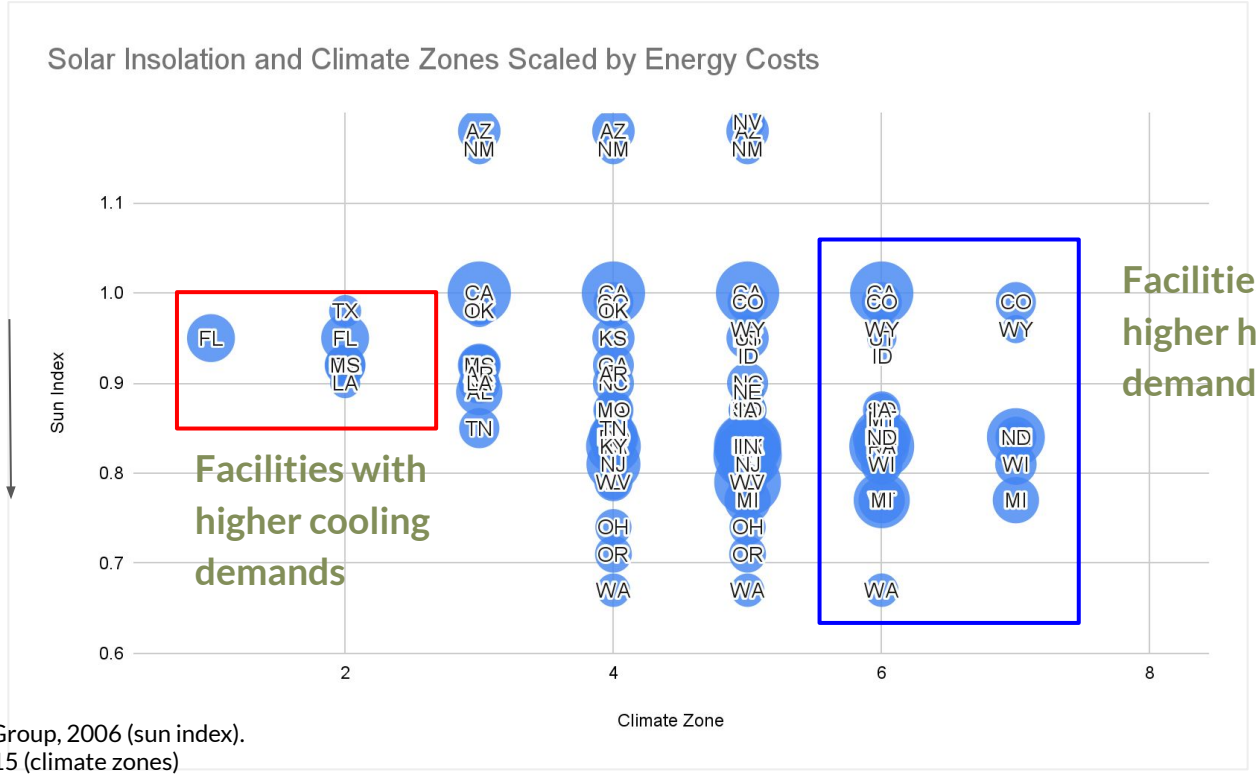
Targeting Producers: Demand for Lighting & HVAC



Facilities in locations with low solar resource

Data credit: Topline Strategy Group, 2006 (sun index)
US Department of Energy, 2015 (climate zones)
EIA, 2021 (energy costs)
Note: AK and HI excluded as outliers for data visualization.

Targeting Producers: Demand for Cooling & Heating



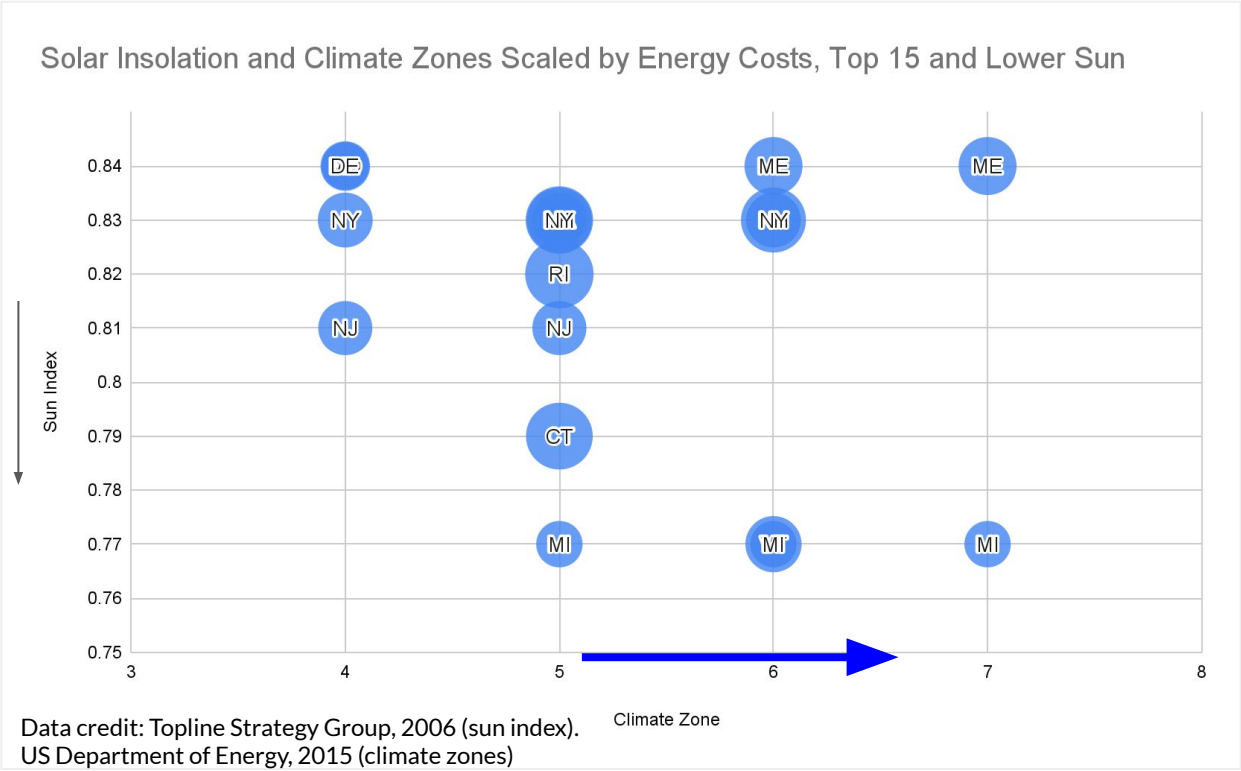
Data credit: Topline Strategy Group, 2006 (sun index).
US Department of Energy, 2015 (climate zones)
EIA, 2021 (energy costs)
Note: AK and HI excluded as outliers for data visualization.

Targeting Producers: Greatest Demand for Lighting & HVAC

Priority states:

1. RI
2. MA
3. CT
4. NH
5. ME
6. VT
7. NY
8. NJ
9. MD
10. DE
11. MI

States with large cohorts of producers with large sales volumes with demand for lighting and HVAC



Data credit: Topline Strategy Group, 2006 (sun index).
US Department of Energy, 2015 (climate zones)
EIA, 2021 (energy costs)
Note: AK and HI excluded as outliers for data visualization.

Targeting Producers: Target States

Priority states:

1. NY
2. CA
3. MI
4. NJ
5. OH
6. FL
7. HI
8. MA
9. NC
10. OR
11. PA
12. ME
13. TX
14. VA
15. CO

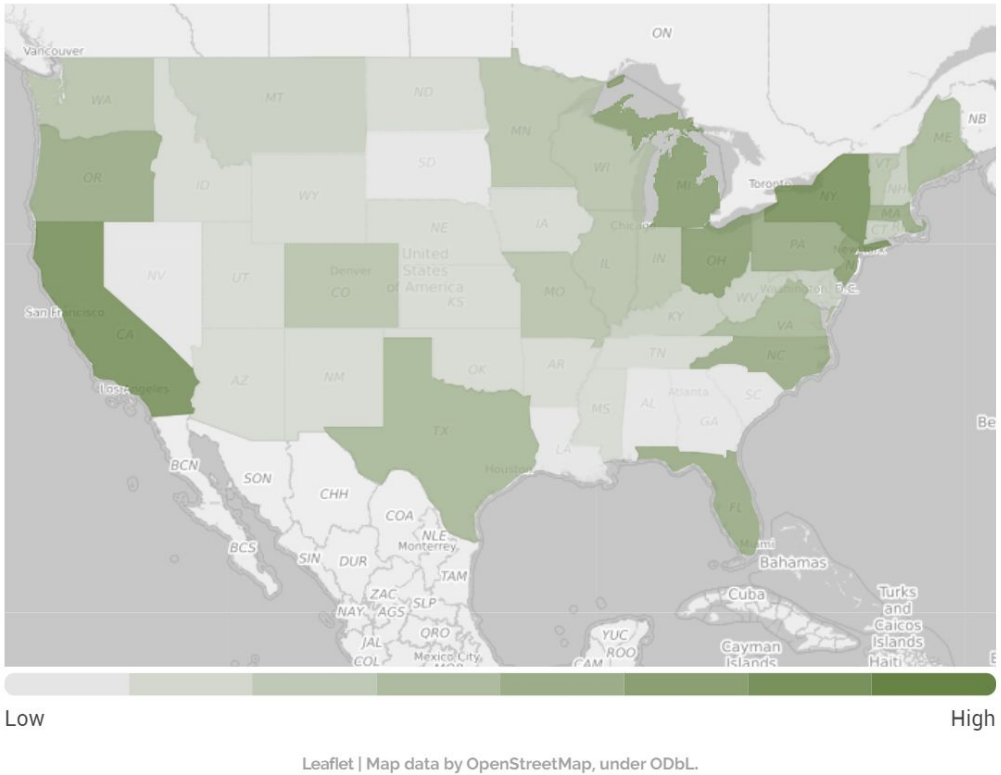
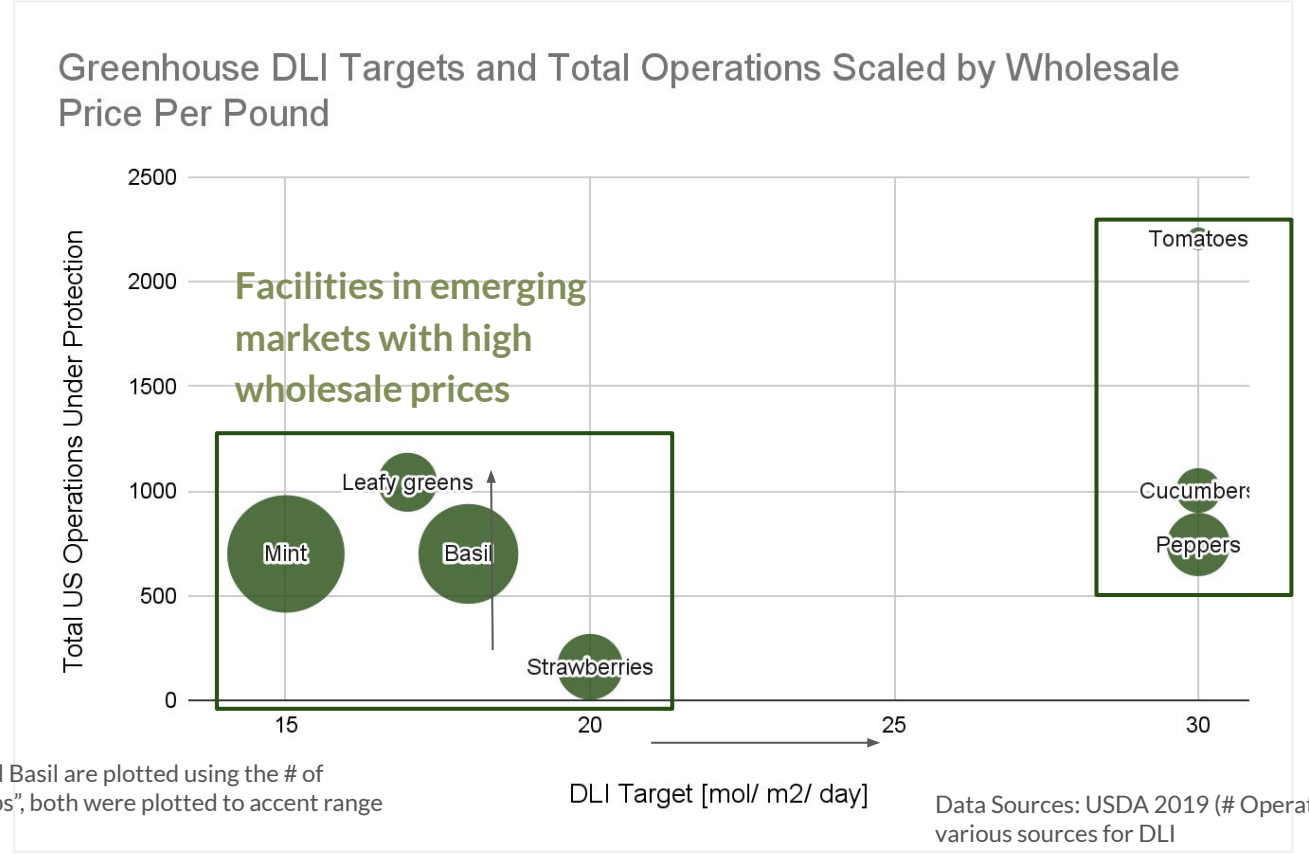


Figure credit: RII, produced with Prezi

Targeting Producers: Greenhouse Producers



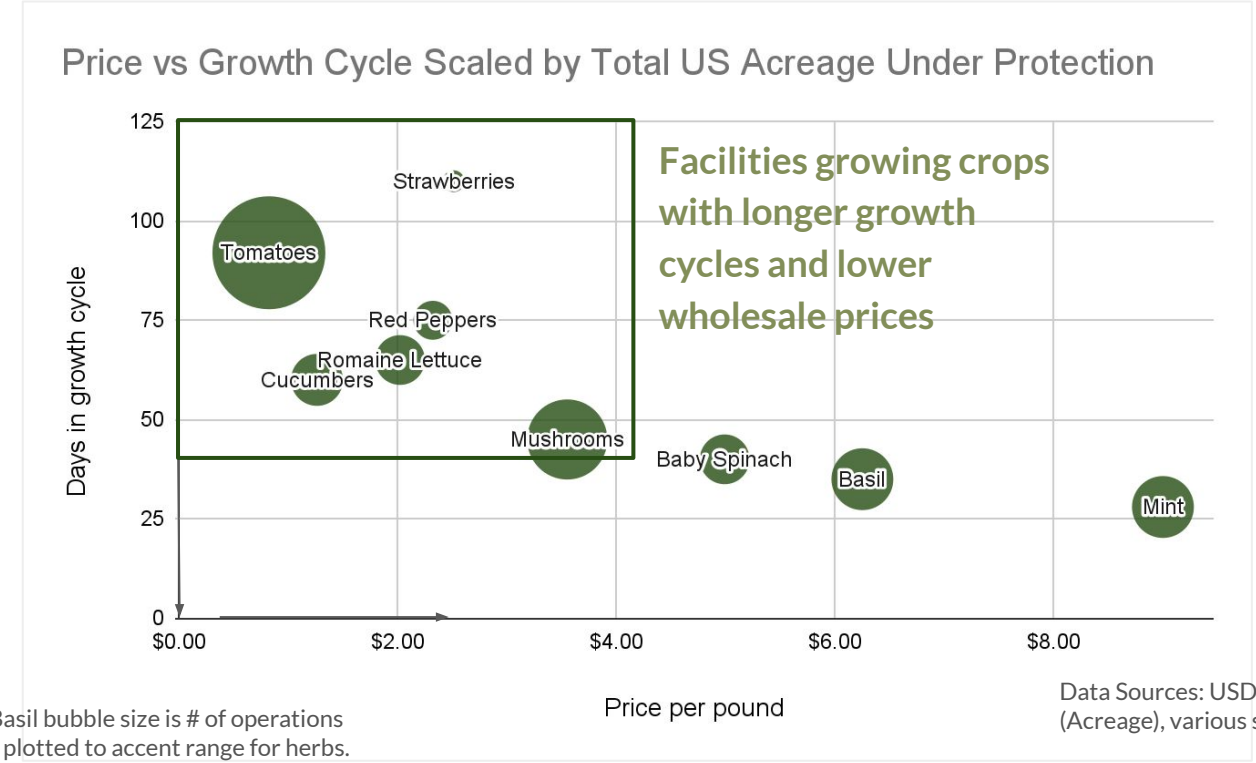
Large cohort of facilities

Facilities with greater need for supplemental lighting

Note: both Mint and Basil are plotted using the # of operations for "herbs", both were plotted to accent range for herbs

Data Sources: USDA 2019 (# Operations), USDA 2021 (pricing), various sources for DLI

Targeting Producers: Faster Harvests & Higher Prices

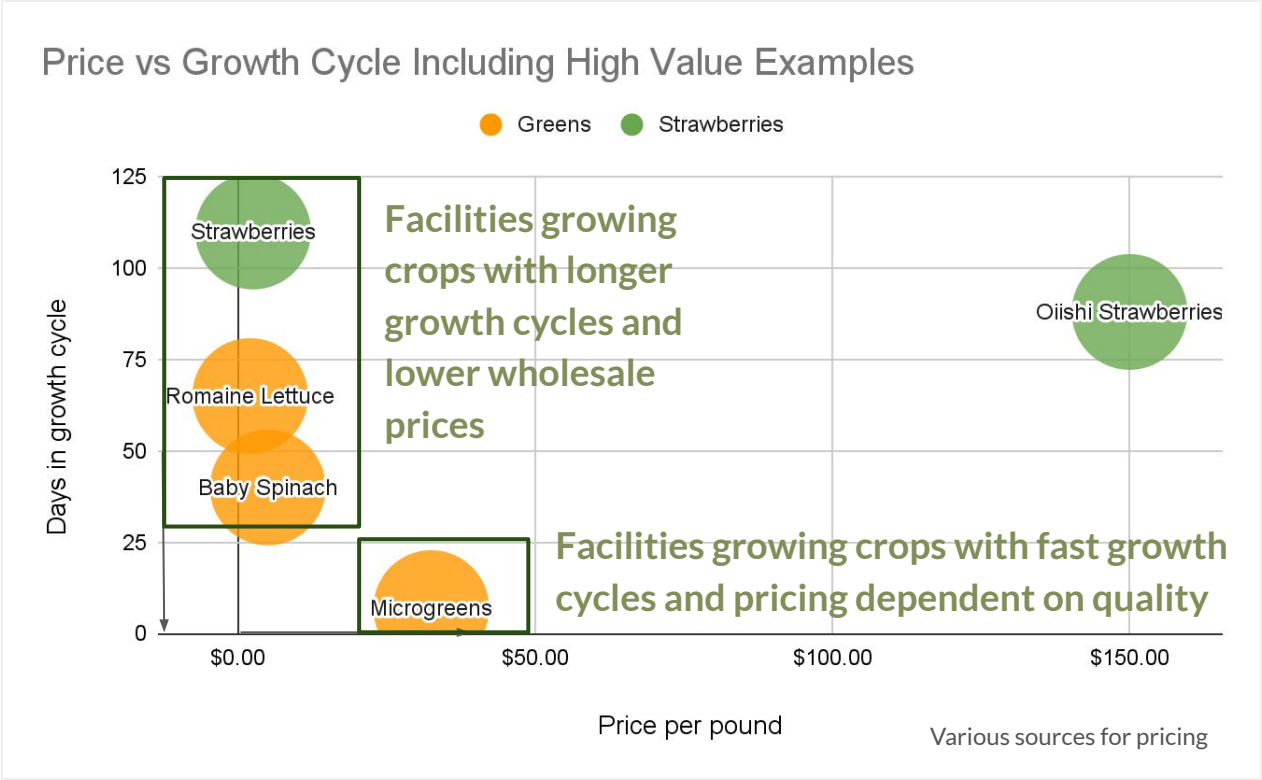


Note: both Mint and Basil bubble size is # of operations for "herbs", both were plotted to accent range for herbs.

Data Sources: USDA, 2021 (pricing), USDA, 2019 (Acreage), various sources for days in cycle

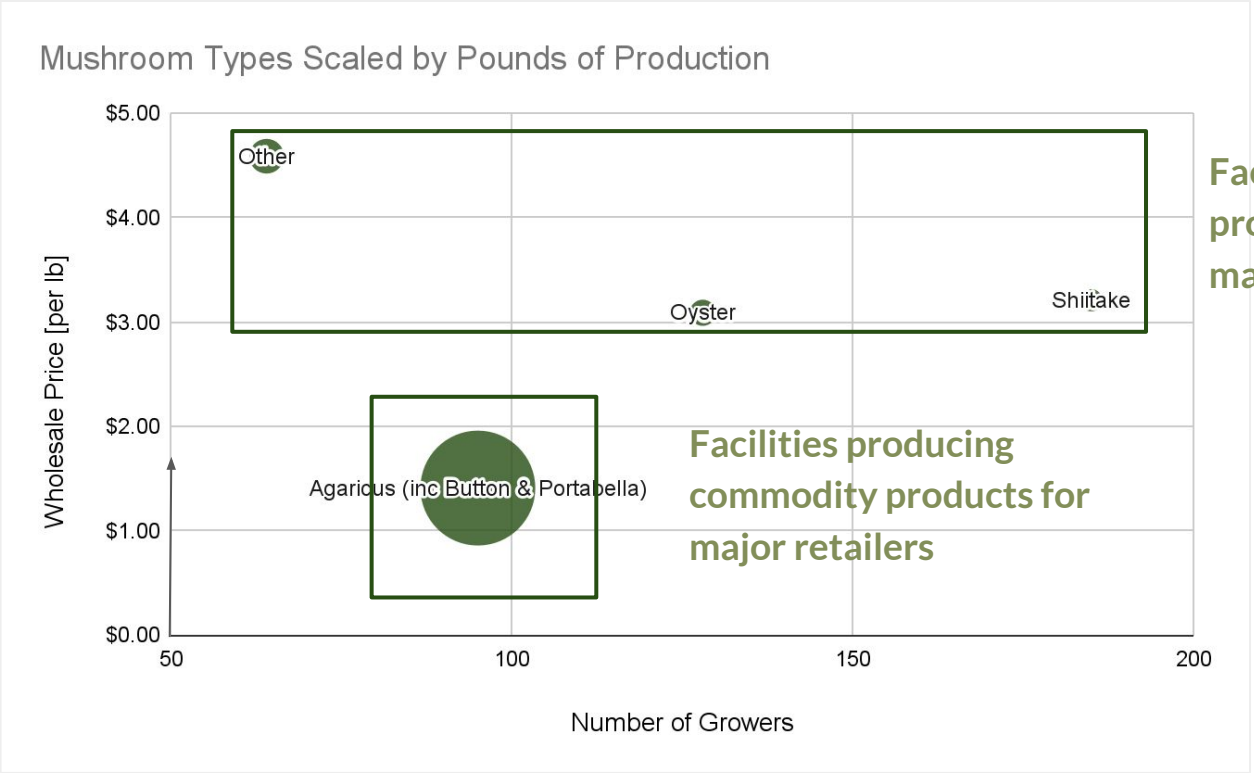
Moving cultivation into controlled environments, crops can be grown out of season, which increases wholesale price

Targeting Producers: High Quality, High Prices



As quality increases in CEA production, wholesale price also increases, especially for indoor producers

Targeting Producers: Mushrooms



Demand for edible mushrooms of culinary value has a CAGR of 8.7% 2020 - 2027

Data Source: USDA, 2019 (table)

Business Wire, 2021 (CAGR)

Targeting Producers: Priority Crops

Higher Priority

Lower Priority

Crop	Class
Vine crops	*Tomatoes*
Mushrooms	*Mushrooms*
Floriculture	*Nursery stock crops*
Vegetables and herbs	*Leafy greens*
Vegetables and herbs	*Microgreens*
Vegetables and herbs	*Fresh herbs*
Vine crops	*Cucumbers*
Vegetables and herbs	*Peppers*
Floriculture	*Finished bedding crops*
Berries	*Strawberries*
Berries	*Other berries*
Cannabis	*Hemp*

Targeting Producers: Type & Size of Facility

Value of Efficiency Varies

Influenced by:

- Facility Size
- Facility Type
- Crop Type
- Energy Demand of Crop

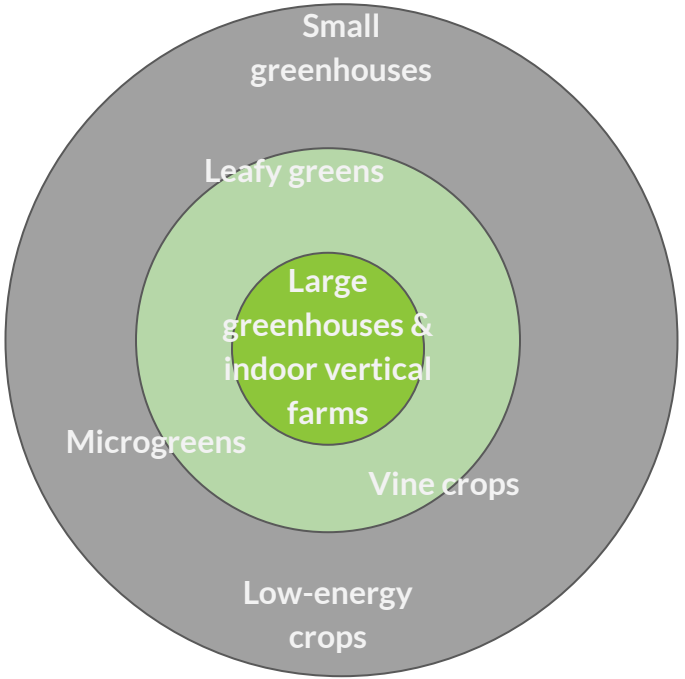
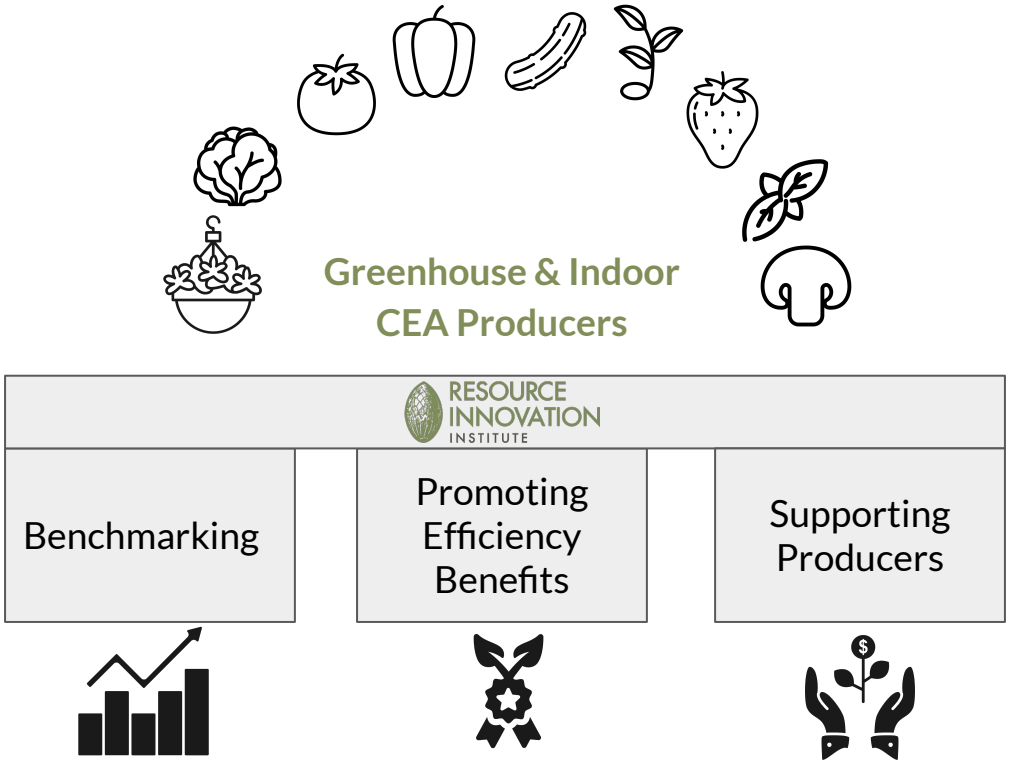


Figure credit: RII

SECTION 04

IMPLEMENTATION PLAN

Market Transformation Implementation Plan



Acknowledgements and Suggested Citation

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