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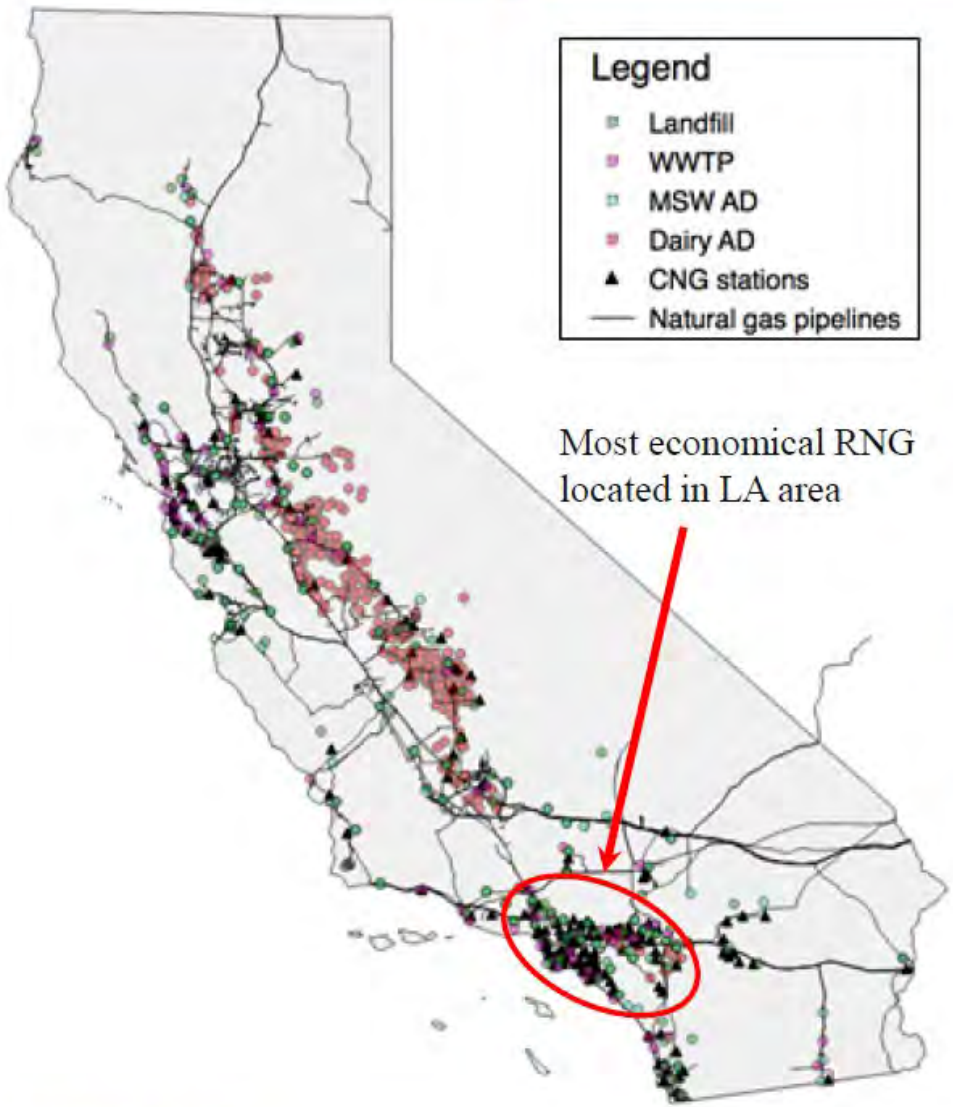
Recovery and Energy with Zero Waste

California's Renewable Gas Potential from Organic Waste

Feedstock	Amount Technically Available	Billion Cubic Feet Biomethane	Million Gasoline Gallon Equivalents	Tons of Hydrogen (assuming 85% conversion efficiency)
Landfill Gas	106 BCF	53	457	
Animal Manure	3.4 M BDT	19.5	168	
Wastewater Treatment Gas	11.8 BCF	7.7	66	
Fats, Oils and Greases	207,000 tons	1.9	16	
Municipal Solid Waste (food, leaves, grass)	1.2 M BDT	12.7	109	
Municipal Solid Waste lignocellulosic fraction)	6.7 M BDT	65.9	568	
Agricultural Residue (Lignocellulosic)	5.3 M BDT	51.8	446	
Forest, Sawmill, Shrub & Chaparral Residues	26.2 M BDT	256	2,214	
BIOGAS POTENTIAL		**468.5**	**4,044**	**4,038,793**

Source: Rob Williams and Stephen Kaffka, UC Davis, presentation to the California Energy Commission on 1/30/17; Lawrence Livermore National Lab assessment of forest, sawmill, shrub & chaparral residues, Jan2020

RNG Estimation Data

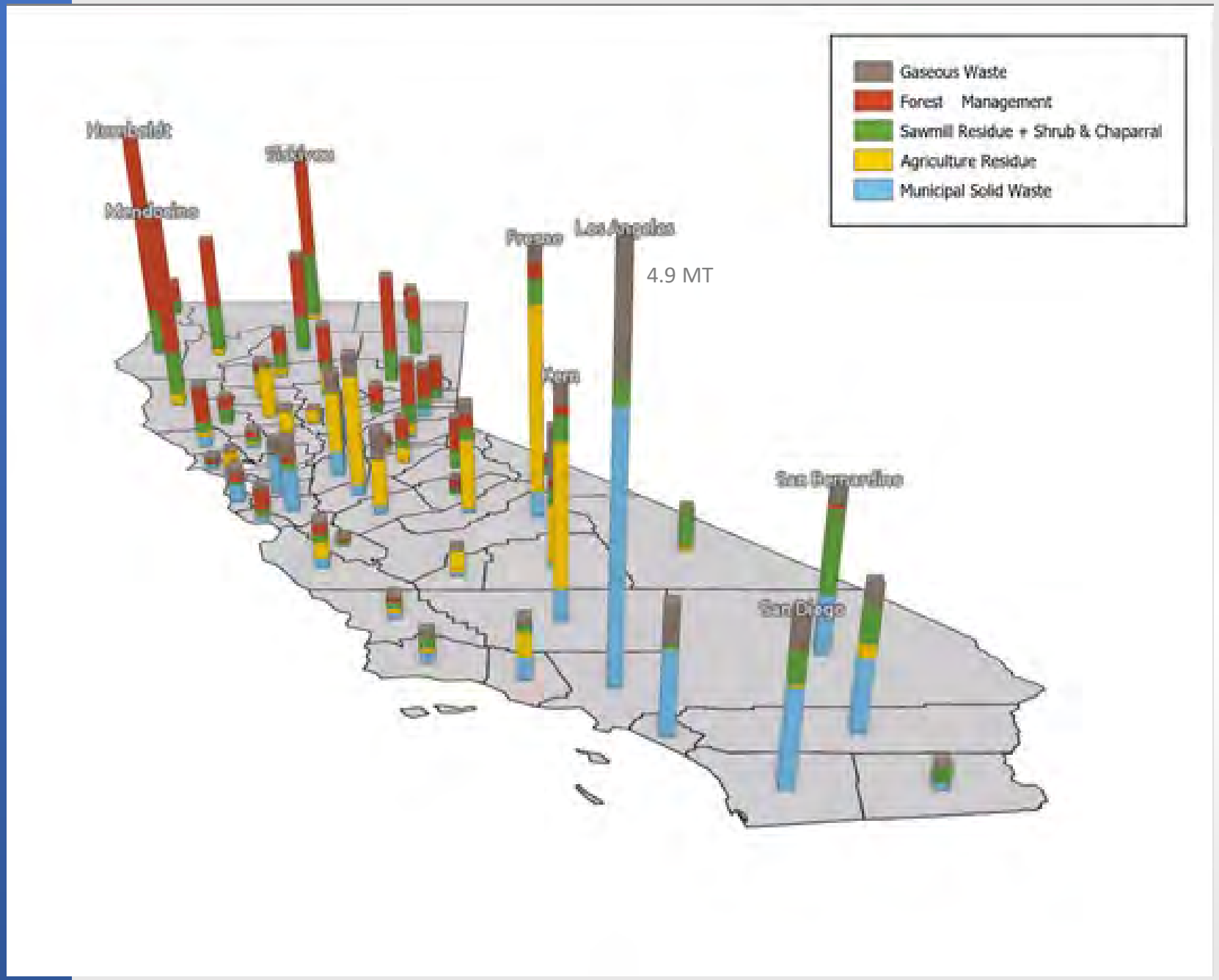


Geolocated Data:

- **Dairies: 1,369 sites**, Central Valley and Santa Ana Regional Water Quality Control Boards
- **Landfills: 147 sites**, Landfill Methane Outreach Program
- **WWTP: 86 sites**, California Association of Sanitation Agencies
- **MSW: 38 sites**, California Biomass Collaborative, Solid Waste Information Systems, CalRecycle

Waste biomass is broadly distributed in California

- We estimate that 58 million bone-dry tons will be available from waste sources in 2045
- 100% conversion to CO_2 would yield 106 MT CO_2
- Only waste biomass considered – no energy crops



Benefits of Bioenergy:

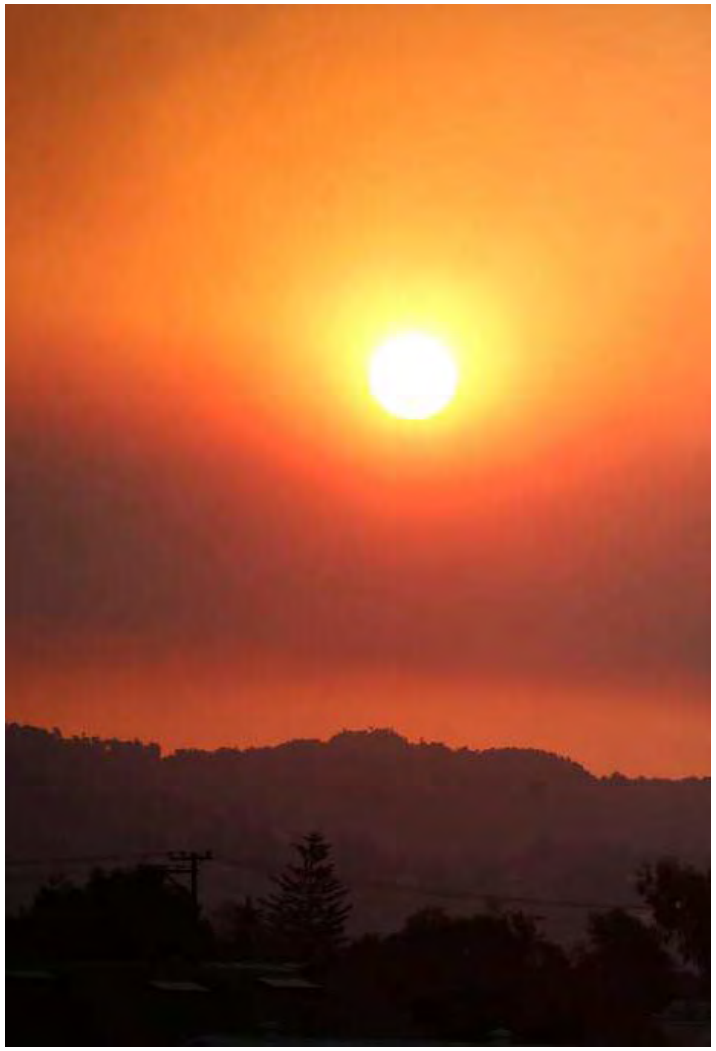
Energy Benefits:

- Energy Reliability
- Firm, renewable power
- Dispatchable power
- Long duration energy storage
- Microgrid support
- Sustainable Aviation Fuels

Public Health, Safety, Economic Benefits:

- Most urgent climate solution
- Protect air quality
- Reduce wildfires
- Reduce open burning of forest & agricultural waste
- Reduce landfilling
- Reduce dairy pollution
- Provide good jobs and economic development

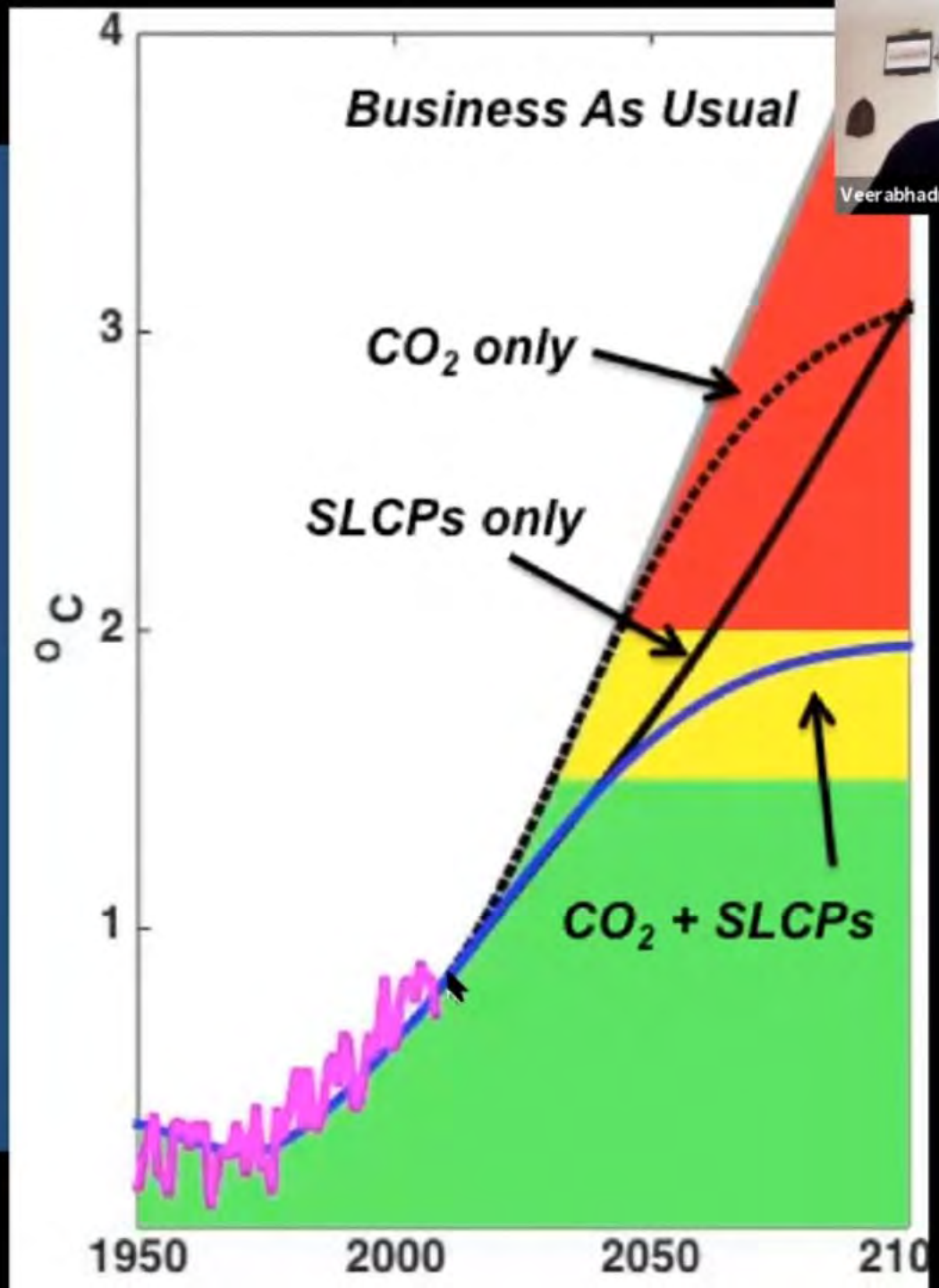
SLCP Cuts = Most Urgent Climate Solution



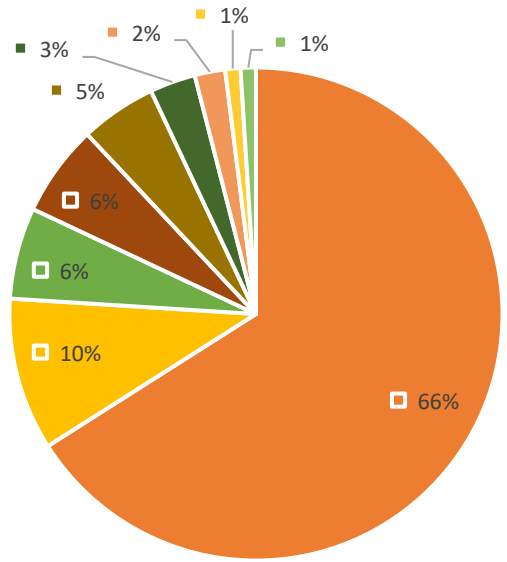
- UN: “Cutting methane is the strongest lever we have to slow climate change over the next 25 years.”
- President Biden: “reducing methane is the single most effective strategy to reduce global warming in the near term”
- CARB: “the science unequivocally underscores the need to **immediately** reduce emissions of short-lived climate pollutants”
- CARB: Reducing SLCPs will “provide immediate benefits – both to human health locally and to reduce warming globally”
- ALA: cutting methane is one of the fastest, best ways to reduce pollution that’s contributing to climate change. The technology is available, and it’s highly cost-effective.”

SLCPs Reductions can bend the warming curve:

0.6 C by 2050
&
1.2 C by 2100

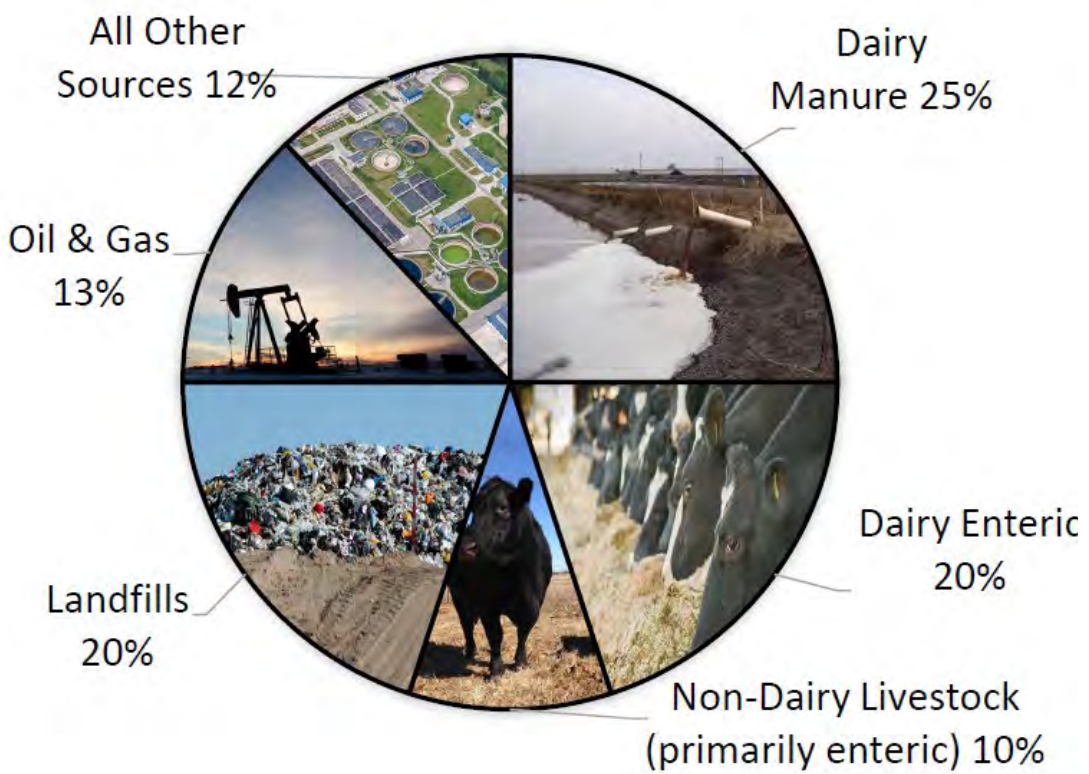


Black Carbon Sources in CA



- Wildfire
- On-Road Vehicles
- Fireplaces
- Miscellaneous
- Off-Road Vehicles
- Industrial Fuel Consumption
- Prescribed Burning
- Ag. Burning

Methane Sources in CA



BC is 3,200x more damaging to climate than CO2 over 20 years

Methane is 84x more damaging to climate than CO2 over 20 years

Sources: California Air Resources Board, *SLCP Reduction Strategy* and *2022 Climate Change Scoping Plan*

Bioenergy = biggest opportunity for carbon negative emissions

BECCS can provide 2/3 of all carbon negative emissions needed to achieve carbon neutrality

- Natural and Working Lands

25 MT/year

- Waste Biomass Conversion to Fuels with CO_2 Storage

83 MT/year

- Direct Air Capture with CO_2 Storage

17 MT/year

Lawrence Livermore National Lab, "Getting to Neutral – Options for Negative Carbon Emissions in California" January 2020

LAO
LEGISLATIVE ANALYST'S OFFICE

Estimated Average GHG Reduction Cost Is High With Wide Variation Across Programs

Estimated Average Cost Per Ton of Reduction Varies Greatly

Program	Cost Per Ton[a]
Organics and recycling loans	$4
Forest health	4
Dairy digester research and development program	8
Organics composting/digestion grants	9
Forest legacy	10
Recycling manufacturing	15
Delta and coastal wetlands restoration	30
State water and efficiency and enhancement program	33
Clean vehicle rebates	46
Sustainable agricultural lands conservation	59
Mountain meadow ecosystems restoration	113
Urban and community forestry	116
Water-energy grant program	141
Affordable housing and sustainable communities	191
Single-family solar photovoltaics[b]	209
Transit and intercity rail capital	259
Single-family energy efficiency and solar water heating[b]	282
Large multifamily energy efficiency and renewables[b]	343
Enhanced fleet modernization program "plus-up"	414
Truck and bus voucher incentives	452
Incentives for public fleets pilot project for DACs	725
Overall Average	**$57**

[a] Calculated as the amount of cap-and-trade funds awarded to a program divided by the total estimated greenhouse gas (GHG) emission reductions from the projects that receive cap-and-trade funds.
[b] Assumes GHG reductions at the midpoint of the administration's estimated range.
DACs = disadvantaged communities.

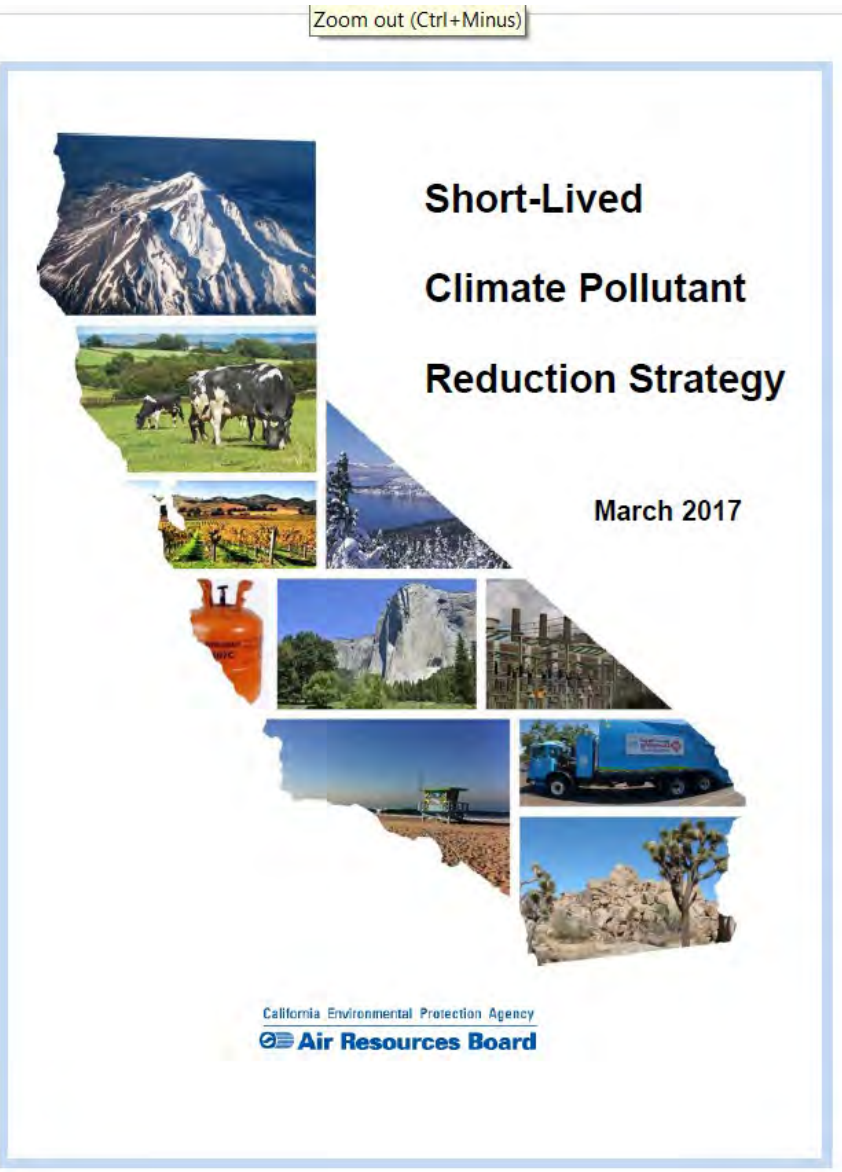
- Administration's data suggests average cost of $57 per ton reduced.

SLCP Reductions are Most Cost-Effective of All Climate Investments

- Dairy digesters and diverted organic waste projects cut carbon for $9 / $10 per ton
- Average cost in CA is ~ $75 per ton of carbon reduction
- Many investments cost > $200 per ton

CA’s Short-Lived Climate Pollutant Strategy

- The State's organic waste should be put to beneficial use for electricity generation, transportation fuel, and pipeline biogas
- Building organic waste to energy facilities and infrastructure would lead to billions of dollars of investment and thousands of jobs in the State
- Lack of bioenergy infrastructure is barrier to achieving SLCP goals



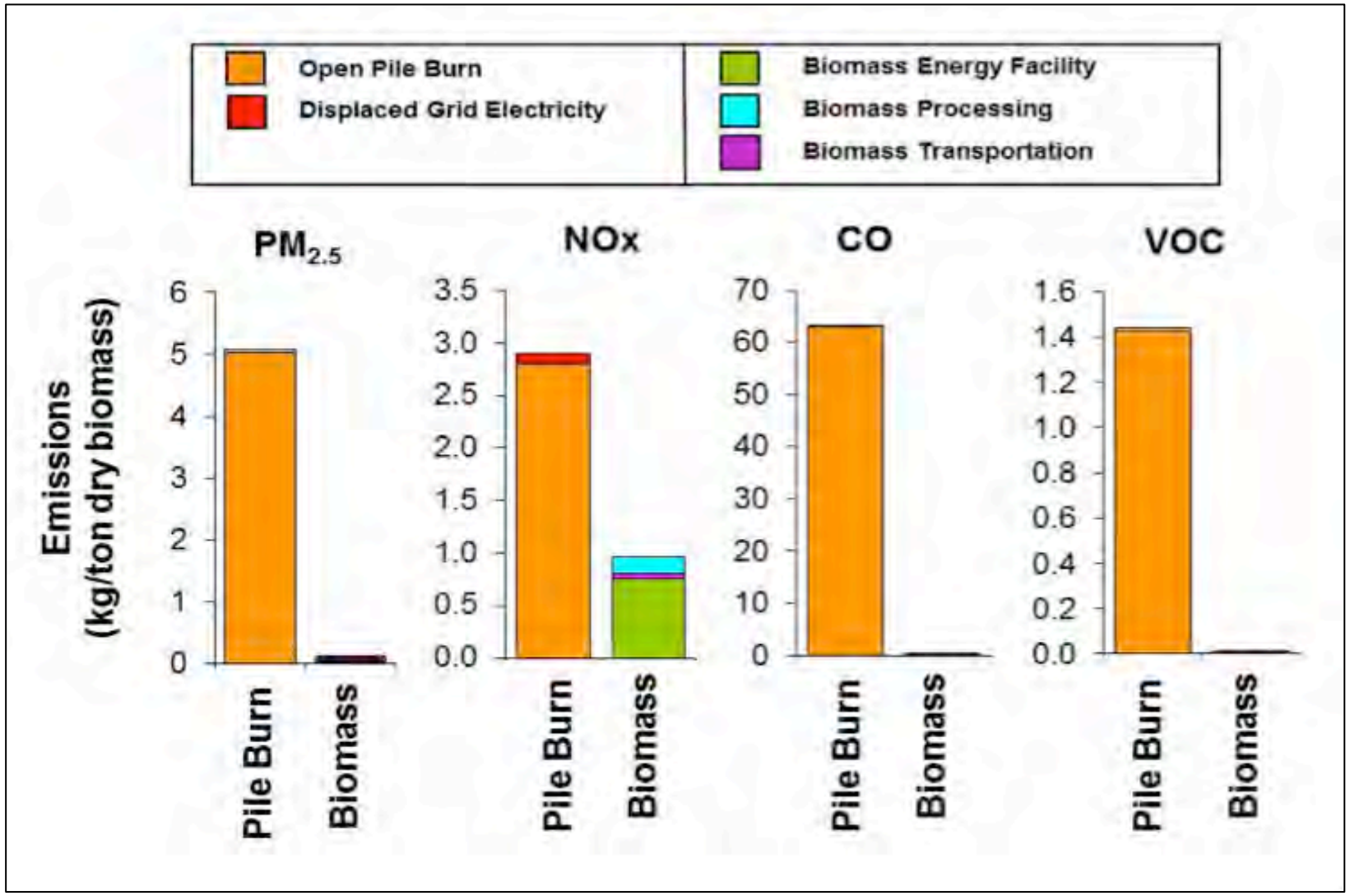
California Forest Carbon Plan (2018)

- Must reduce carbon losses from wildfire and controlled burns to meet CA climate goals.
- Lack of bioenergy infrastructure is major barrier
- Must quickly develop new, small-scale bioenergy facilities
- Must fully implement BioMAT program
- Must triple forest fuel removal by 2030

CalEPA
California Environmental Protection Agency

CALIFORNIA natural resources AGENCY

CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
CAL FIRE
SINCE 1885



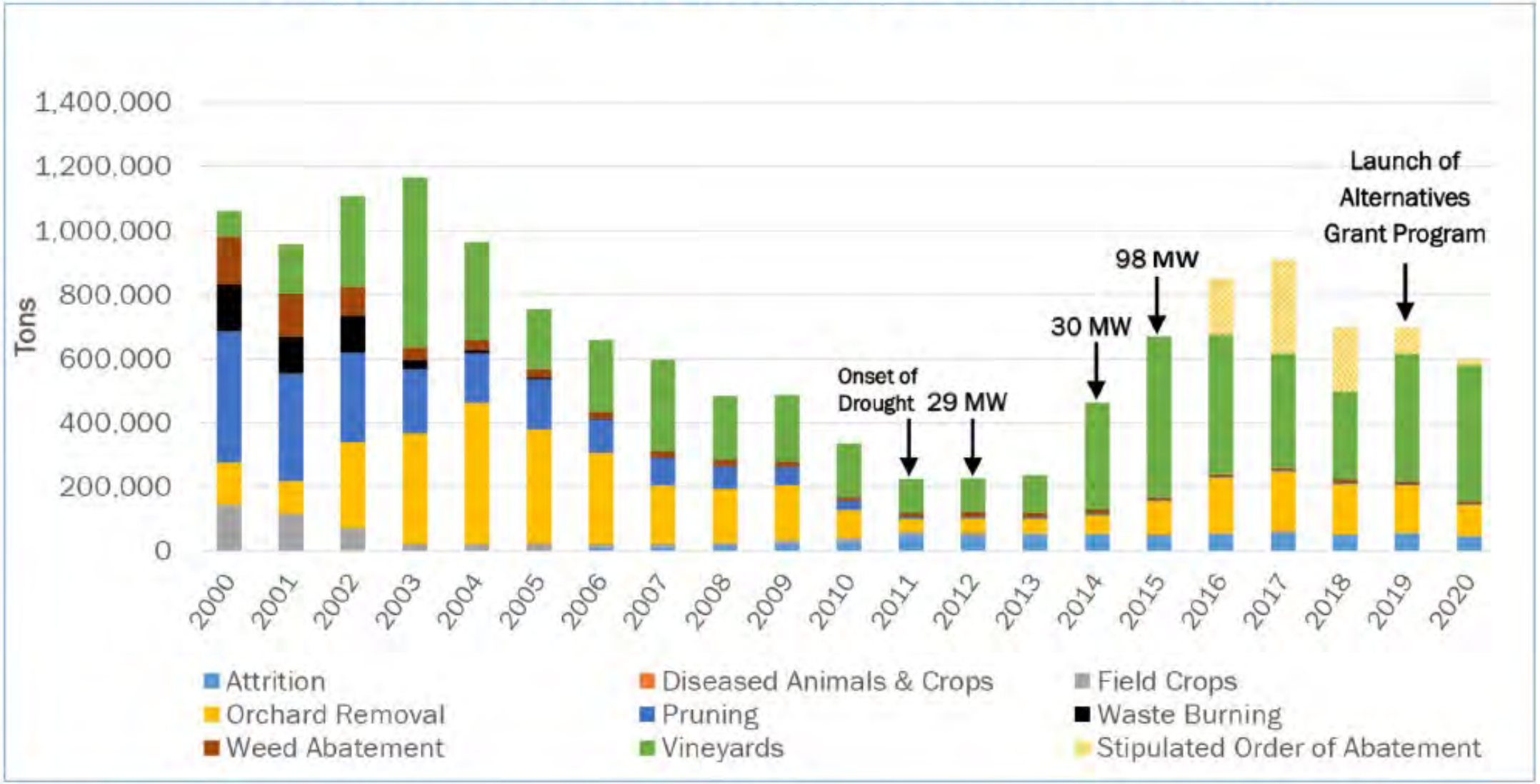
Biomass Power Reduces:

- PM2.5 by 99%
- Methane, other VOCs by 95-99%
- NOx by 40-70%

Source: Placer County Air Pollution Control District and the California Association of Air Pollution Control Officers

- Diesel trucks = largest source of air pollution in SJ Valley and South Coast Air Districts
- Diesel causes half the NOx and Toxic Air Contaminants in SJ Valley
- Biogas and H2 can cut those pollutants 90-99%

Historical Agricultural Material Burned under Rule 4103 and Reductions in Biomass Capacity



District's 2020 Ag Burn Report

- 2020 Report provides staff recommendations on feasibility of further potential prohibitions on agricultural burning in the Valley, and establishes final framework for phase-out, as feasible, of remaining crop categories
  - New prohibitions on open burning reliant on newly emergent alternatives
  - Call for increased funding to assist with widespread transition to costly new alternatives
  - Call for enhanced state energy policies to support development of new bioenergy
  - Partnerships with agricultural stakeholders, CARB, and USDA-NRCS to assist with developing new alternatives

Energy Reliability

- Local energy supplies, distributed generation
- Firm, renewable power / dispatchable power
- Long duration energy storage

Fort Hunter Liggett – Monterey County

- U.S. Army has zero waste and zero net energy goals
- U.S. Army Base Fort Hunter Liggett gasifying on-base waste to produce electricity and vehicle fuels

Miramar Marine Corps Air Station

- 20 MW microgrid in San Diego County
- Includes 3.2 MW of landfill gas powered flexible generation
- The microgrid uses solar energy and biomethane to keep mission-critical buildings operational during power shut-offs.

Biogas / RH2 can Provide Locally Sourced, Carbon Negative Generation and Storage

THANK YOU

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Bioenergy Association of California

BEAM CIRCULAR

BIOECONOMY • AGRICULTURE • MANUFACTURING

CEC Climate Innovation Program
Forests and Agriculture Workshop

December 12, 2023

Karen Warner, CEO, BEAM Circular

BioEconomy, Agriculture, & Manufacturing (BEAM) Initiative:

a regional strategy for global leadership in the circular bioeconomy

BEAM's Strategy

- Cross-Cutting Initiatives
- Infrastructure
- Talent
- Innovation
- Capital

BEAM CIRCULAR

BEAM Circular, a nonprofit organization, serves as the backbone for the BEAM Initiative. Our mission is to unlock the power of agricultural communities to transform waste into economic opportunity and environmental solutions.

WE ARE UNLOCKING THE POWER OF AGRICULTURAL COMMUNITIES TO TRANSFORM WASTE INTO OPPORTUNITY THROUGH THE CIRCULAR BIOECONOMY.

Bioindustrial Manufacturing: Diverse Inputs, Technologies, and Outputs

FEEDSTOCKS (BIOMASS)
agricultural residues, wood & forestry residues, municipal solid waste / green waste, food processing byproducts, wastewater sludge

CONVERSION
biological (fermentation, anaerobic digestion), chemical, thermochemical (pyrolysis, gasification)

PRODUCTS
fuels, chemicals, solvents, detergents, plastics, films, fabrics, polymers, ag inputs, food additives, fragrances, alternative proteins, construction materials

Examples: Materials & Chemicals

- Biomanufacturing can advance climate goals not only through prevention of GHG emissions from biomass waste, but through diversion of use of petrochemicals and high-polluting industrial processes.
- Of note: Cement is the 2nd-largest industrial source of carbon pollution in CA after oil and gas production, and accounts for roughly 8% of all global GHGs.

Alignment with Local, State, Federal Priorities

Cleaner Air & Water

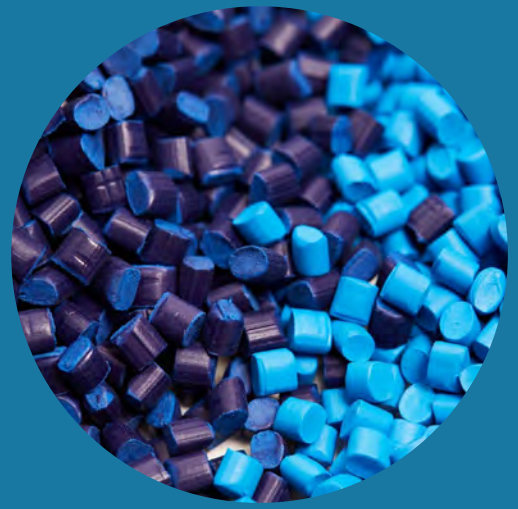
Wildfire Management

Food & Ag Resilience

Quality Jobs

Supply Chain Independence

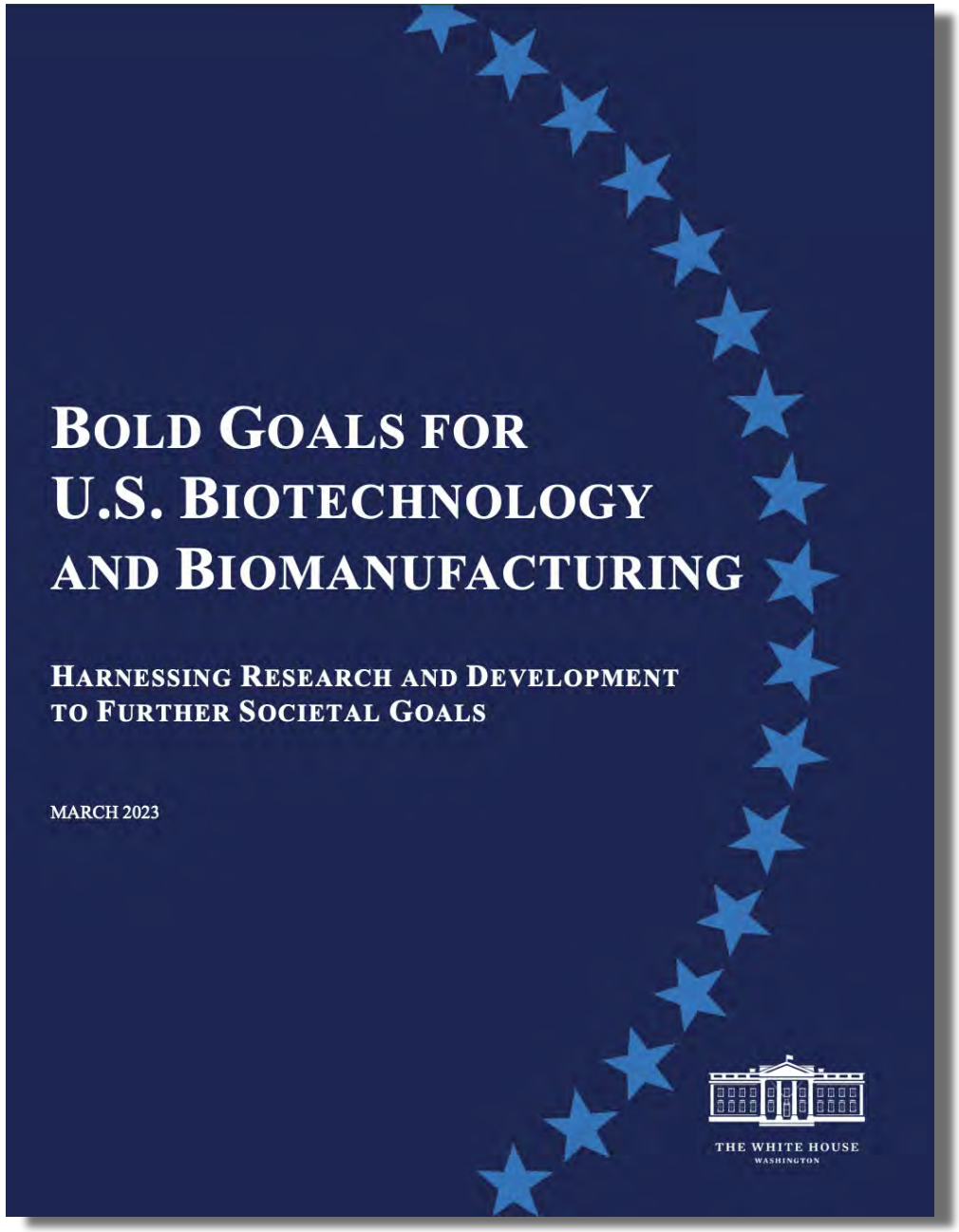
Transition to Carbon Neutrality



Bioeconomy has become a key federal priority

"The world is on the cusp of an industrial revolution fueled by biotechnology and biomanufacturing… Through biomanufacturing, sustainable biomass across the United States can be converted into new products and provide an alternative to petroleum-based production for chemicals, medicines, fuels, materials, and more… **Biotechnology and biomanufacturing are expanding to build products that will be everywhere in our lives and support climate and energy goals, improve food security, and grow the economy across all of America.**"

- *Bold Goals for US Biotechnology and Biomanufacturing*, White House Office of Science and Technology Policy, March 2023

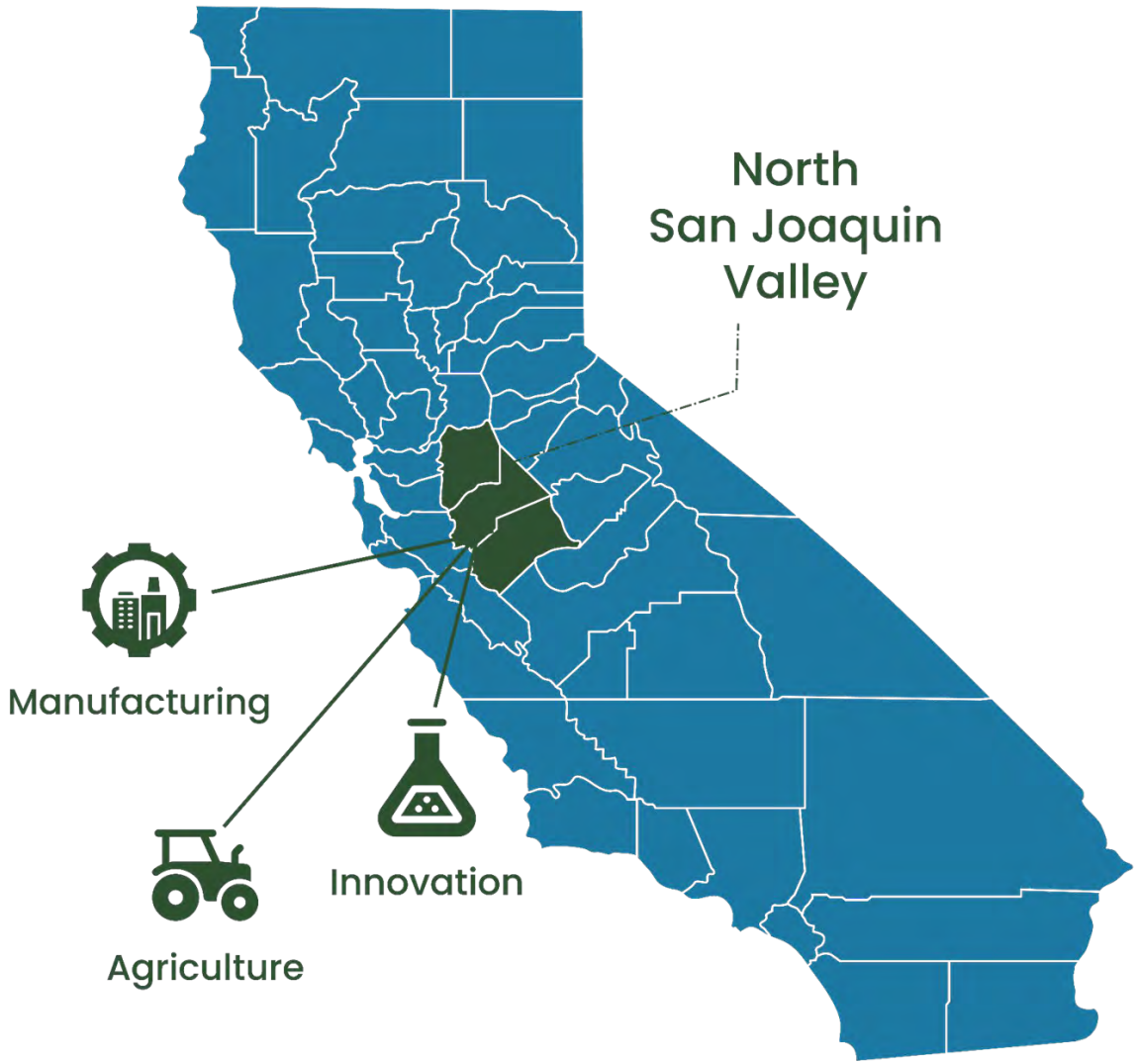


Federal investments in the bioeconomy (highlights)

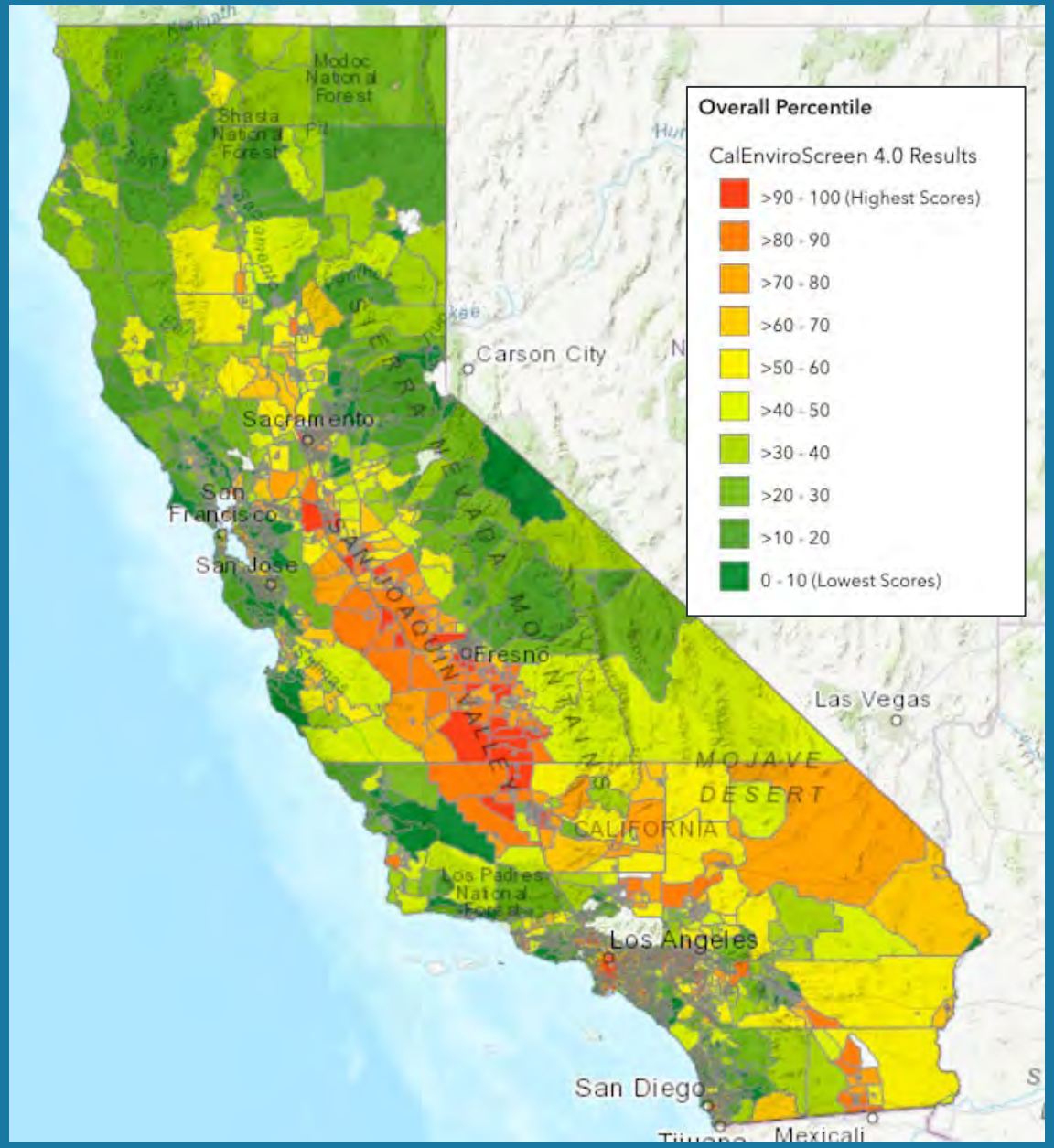
- Department of Defense $1.2 billion investment in bioindustrial domestic manufacturing infrastructure over 5 years
- DOD-funded BioMADE investing in regional hubs and a network of 12 bioindustrial manufacturing testbed facilities
- USDA investments in sustainable fertilizers, wood product innovation
- DOE innovation investments, including in R&D for conversion of biomass to fuels and chemicals and improved bio-plastics
- SAF Grand Challenge (DOE, DOT, USDA)
- Intersections and alignment with criteria for NSF Regional Innovation Engines; CHIPS; IRA; IIJA

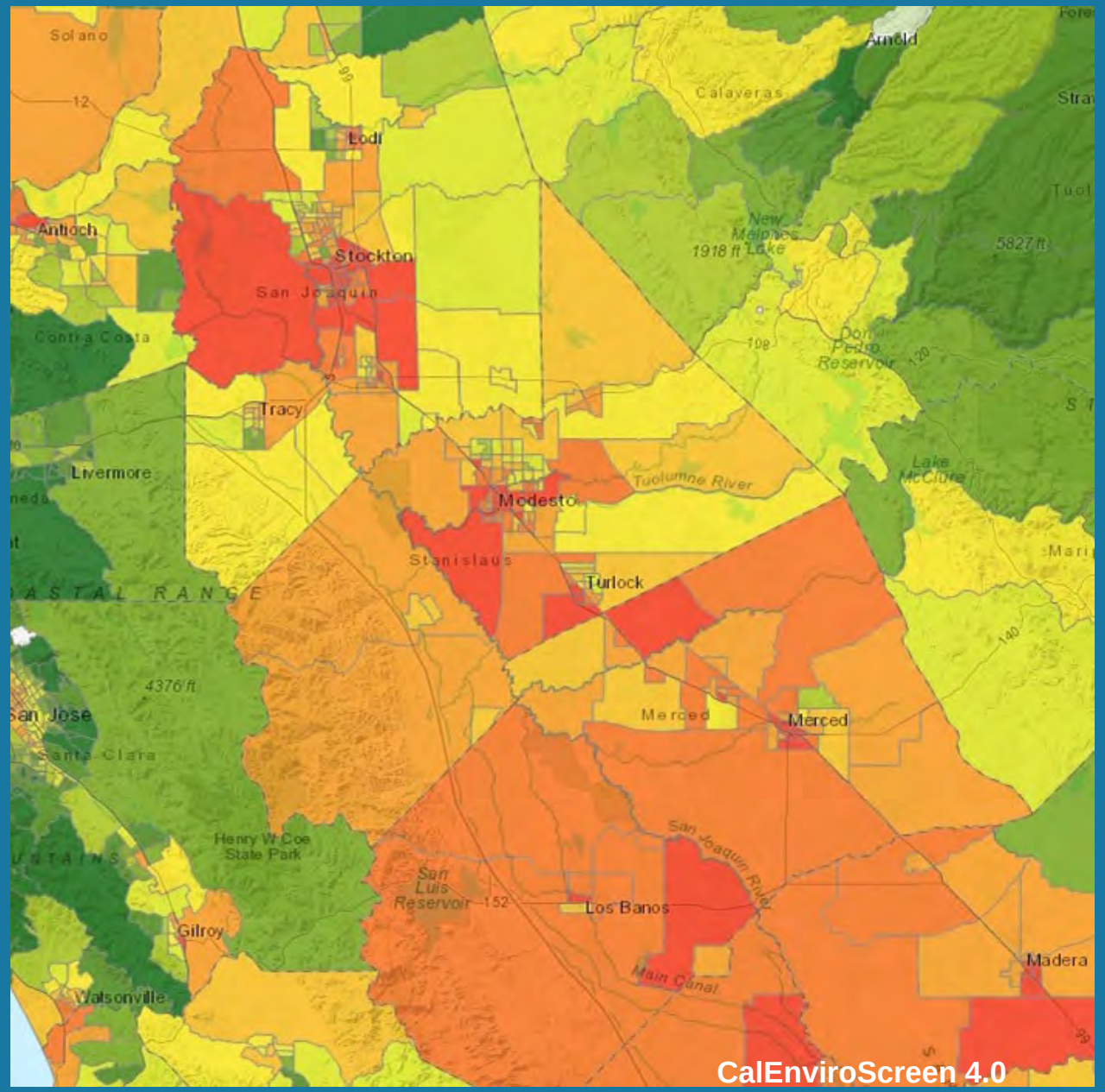
BEAM's strategic anchor region

- NSJV = Merced, San Joaquin, & Stanislaus Counties, 1.6 million people
- CA's agricultural heartland, directly neighboring Bay Area biotech hub to West and forested Sierras to East
- Produces 30% of California's almonds
- Global food manufacturing leader across multiple categories



Disinvested Communities Positioned to Lead and Benefit from Bioeconomy





Bioproducts face barriers to scale from Lab to Market

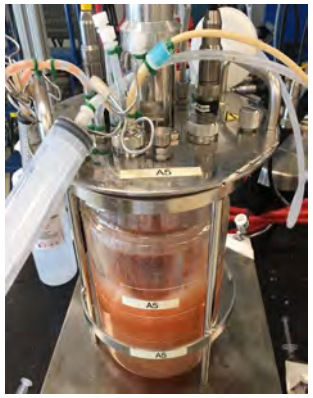
Research & Development

Scale-Up

Manufacturing

Micro Scale
< 1 mL, HT

Bench Scale
100 mL – 20 L



Pilot Scale
50 L – 1000 L

Demo Scale
10 m^3 – 50 m^3

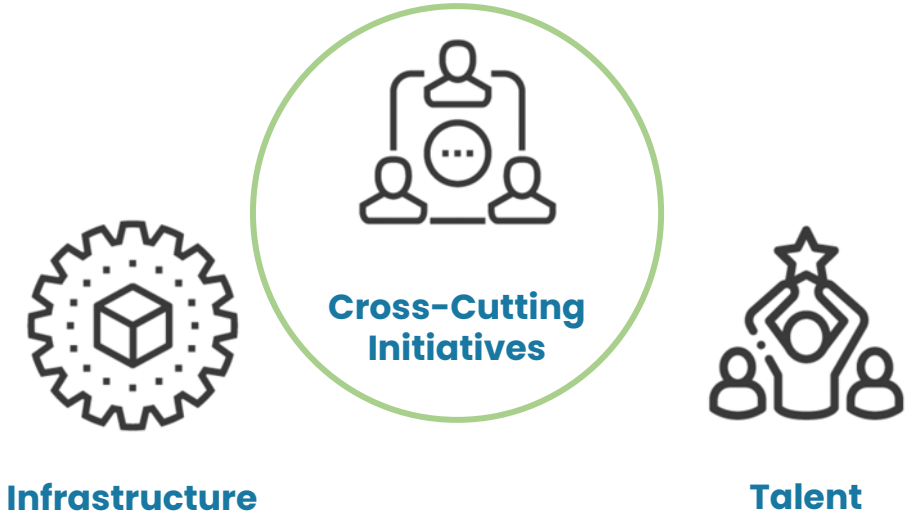
Commercial Scale
100 m^3 +

BEAM's Focus

Key Need for CA: Bioindustrial Manufacturing Scale-up Capacity

- BEAM's testbed contract biomanufacturing facility will help firms **move from lab-based viability to commercial manufacturing**
- Designed strategically to fill critical market gaps and support diverse feedstocks/products

Phase 1 of facility design completed with leading national biomanufacturing design firm Next Rung Technologies

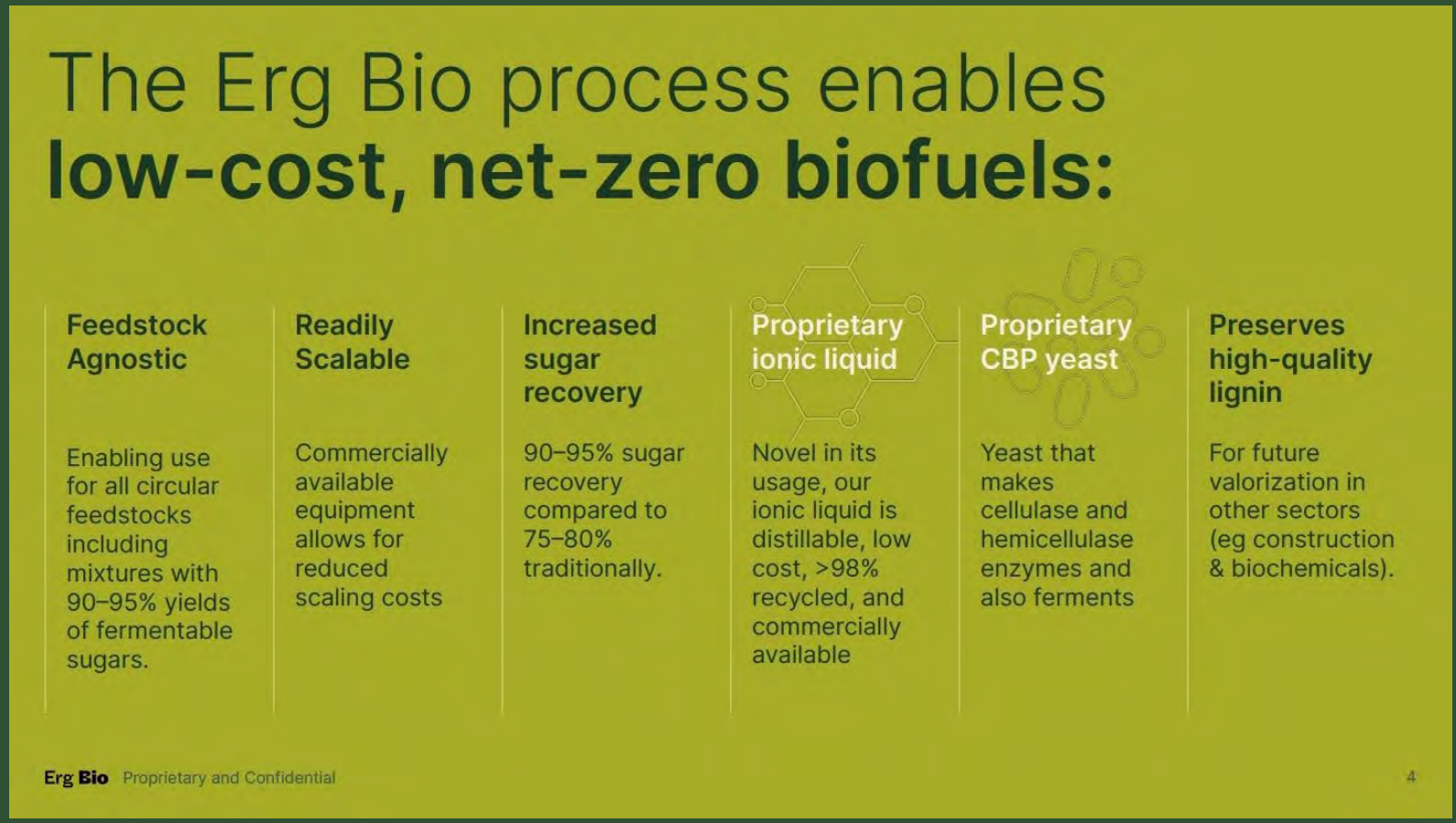


Critical Area for Investment: Feedstock Diversification

R&D and scale-up of innovation is urgently needed to advance the use of CA's diverse sources of biomdss from waste-streams and residues of food, agriculture, and forestry

Example: Erg Bio

- Unlocks the potential of diverse feedstocks
- Ready to build demo-scale facility



Growing Coalition of Partners

BEAM CIRCULAR

BIOECONOMY • AGRICULTURE • MANUFACTURING

Thank you!

www.beamcircular.org
karen@beamcircular.org

Wood Products & Bioenergy

JOHN MCCARTHY| WOOD PRODUCTS & BIOENERGY PROGRAM MANAGER

DECEMBER 12, 2023 | CEC CLIMATE INNOVATION PROGRAM WORKSHOP

Agenda

1) Wildfires and Forest Health
2) CAL FIRE's Roles
3) The Million-Acre Strategy
4) State Investments
5) Innovation Needs

A Century of Change: 1909 to 2015

478,962
Total Emergency Responses

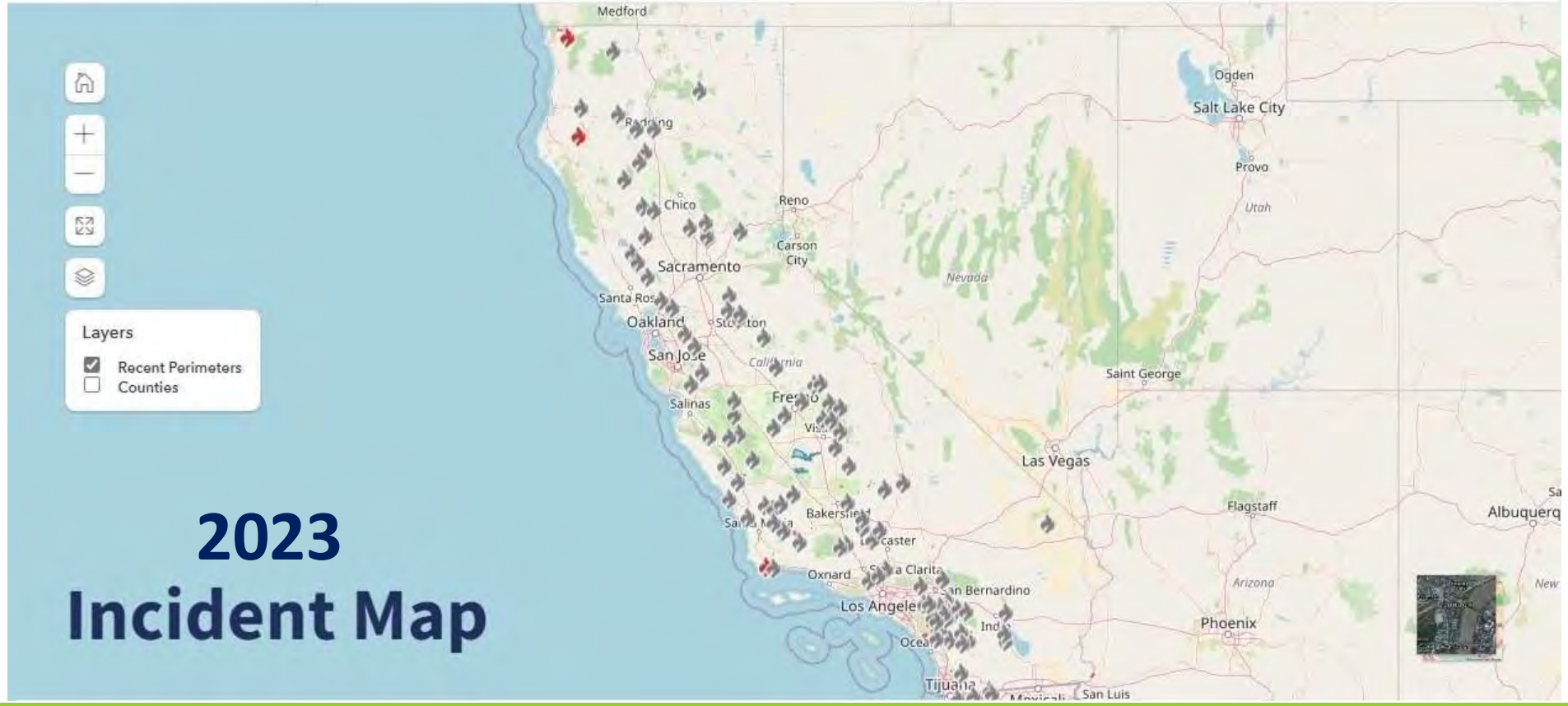
6,545
Wildfires

319,070
Acres Burned

= 128,000 ha

4
Fatalities:
1 Civilian / 3 Firefighter

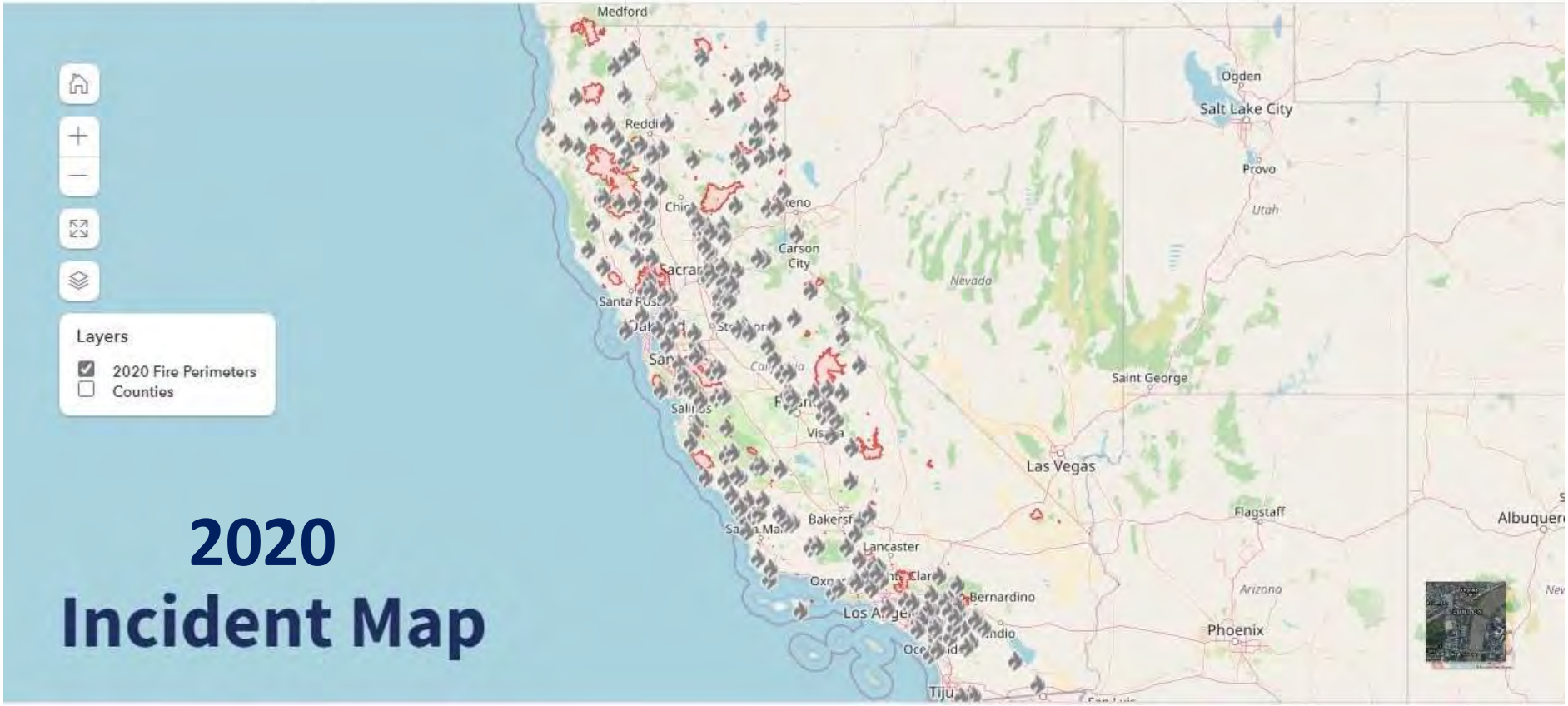
71
Structures:
19 Damaged / 52 Destroyed



2023 Incident Map

494,489	8,648	4,304,379	33	11,116
Total Emergency Responses	Wildfires	Acres Burned	Confirmed Loss of Life	Structures Destroyed

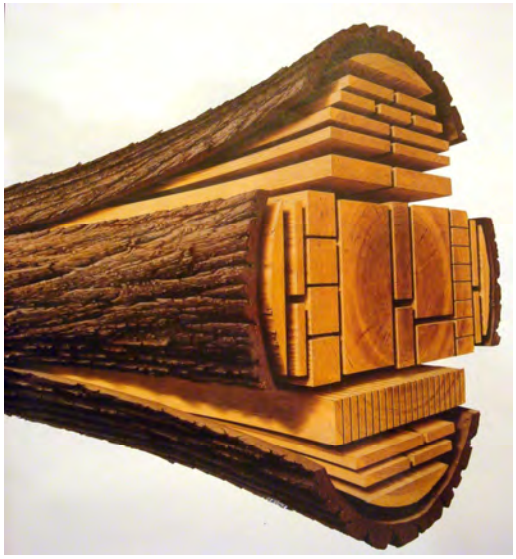
= 1,740,000 ha



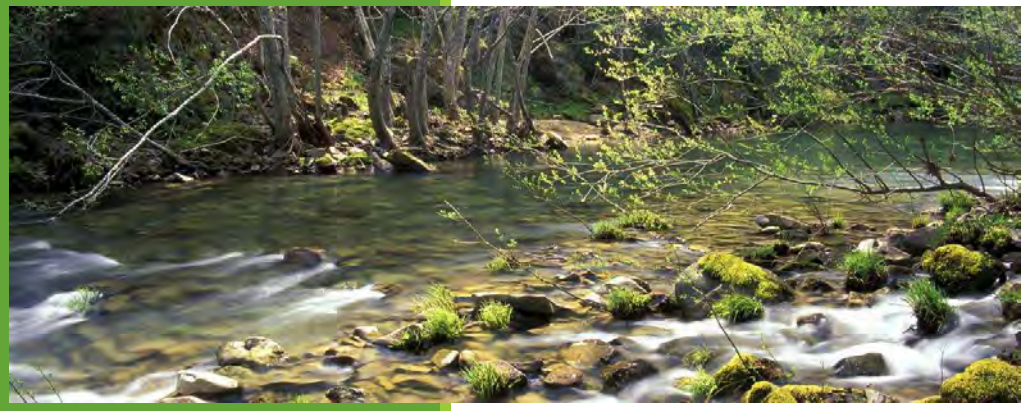
2020 Incident Map

How can we restore historic conditions?

Historic Logging and Milling



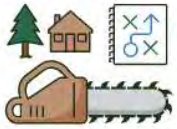
“Forest” Products



Forest Waste

CAL FIRE'S GRANT PROGRAMS

FIRE PREVENTION



ACTIVITIES

- Hazardous Fuels Reduction
- Wildfire Prevention Planning
- Wildfire Prevention Education

FOREST HEALTH

ACTIVITIES

- Forest Fuels Reduction
- Prescribed Fire
- Pest Management
- Reforestation
- Biomass Utilization

CALIFORNIA FOREST IMPROVEMENT PROGRAM *COST-SHARE*

ACTIVITIES

- Forest Improvement
- Reforestation
- Planning

FOREST LEGACY

ACTIVITIES

- Conservation Easements
- Fee Title Purchase

BUSINESS & WORKFORCE DEVELOPMENT

ACTIVITIES

- Workforce Training
- Research and Development
- Business Development
- Biomass
- Wood Products
- Tree Nurseries

URBAN & COMMUNITY FORESTRY

ACTIVITIES

- Urban Tree Planting
- Planning
- Workforce Development
- Education

WILDFIRE RESILIENCE *BLOCK GRANT*

ACTIVITIES

- Forest Improvement
- Reforestation
- Technical Assistance
- Planning

TRIBAL FOREST RESTORATION

ACTIVITIES

- Under Development

RURAL FIRE CAPACITY

ACTIVITIES

- Firefighting Support

www.fire.ca.gov

Wood Products & Bioenergy Team

Our Mission

Maintain and enhance the forestry-sector infrastructure of California to support healthy resilient forests along with the people and ecosystems that depend on them.

Grants: $100+ million to 90 Grantees

Workforce Development

- **$46 million awarded**
  - Community colleges
  - Prescribed fire training
  - Forestry mentor programs
  - Training for formerly incarcerated

Business Development

- **$57 million awarded**
  - Wood processing facilities
  - Bioenergy
  - In-woods operations
  - Research and Development
    - Biomass fuels
    - Biochar marketing
    - Feasibility studies
  - Tree Nurseries
  - Cone Collection

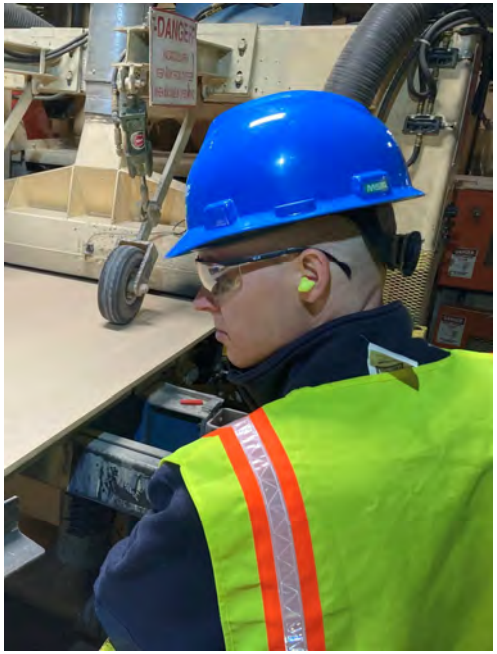
Bioenergy Grantees

- Caribou Biofuels
- Aemitis
- Blue Mountain Electric Company
- Force Energy
- Mendocino Forest Products
- Tuolumne Biomass
- Yosemite Clean Energy
- Mt Lassen Power
- Northstar Community Services District
- Arbor Energy
- Community Renewable Energy (Dinuba)
- Mote
- Mariposa Bioenergy
- Woodland Biomass Power
- Atlas Tree

Workforce and Business Development Grant Solicitation in 2024

- New grant solicitation in January 2024
- See the Wood Products & Bioenergy webpage and subscribe for updates
- New grant guidelines will be posted
- Available funding will be posted
- <2-year projects
- Applications due in early March

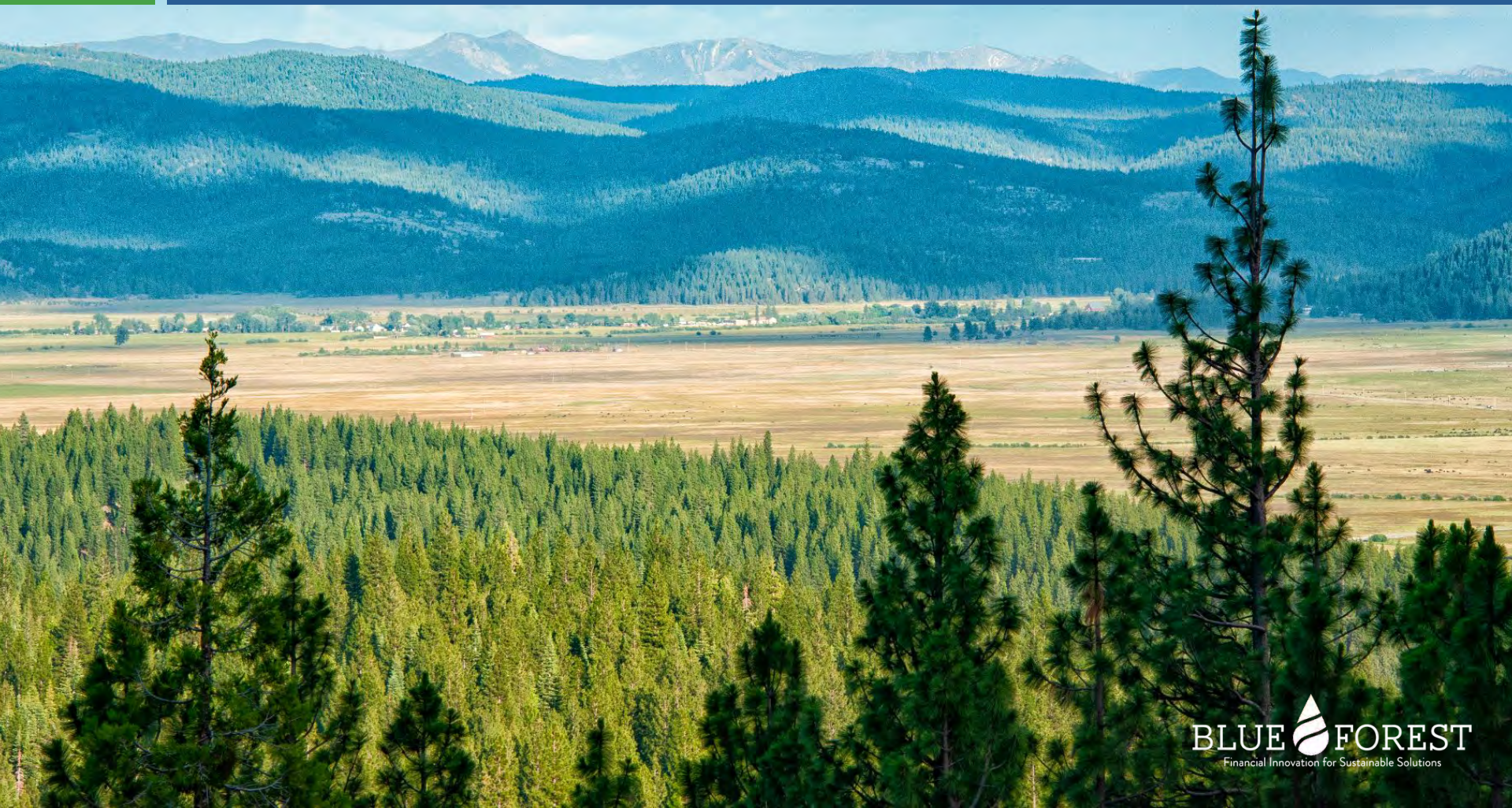
Wrap up and Questions



CALIFORNIA WILDFIRE INNOVATION FUND I

Investing in The Circular Bioeconomy

DECEMBER 12, 2023



BLUE FOREST

Financial Innovation for Sustainable Solutions

AGENDA

I. **ABOUT BLUE FOREST**

II. CALIFORNIA WILDFIRE INNOVATION FUND I

BLUE FOREST
Financial Innovation for Sustainable Solutions

Fighting Fire with Finance

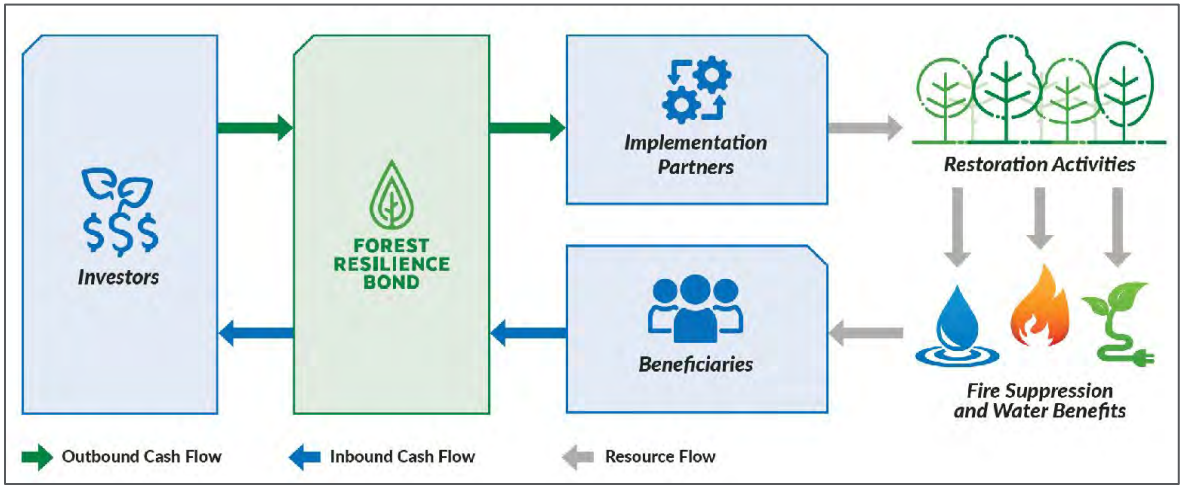
About Blue Forest

- Blue Forest Finance Inc. is a mission-driven, non-profit organization creating **sustainable financial solutions to environmental challenges**
- An **interdisciplinary team of 30+** scientists, finance experts, and engineering professionals
- **Leading asset manager focused on reducing wildfire risk** through forest restoration; first investment partner of the USDA Forest Service

2015	**Blue Forest Finance Founded**
2017	**MOU Signed with US Forest Service**
2018	**$4 million Yuba I FRB launched**
2020	**BFF became 501c3**
2021	**$11 Million Yuba II FRB launched** **Challenge Cost Agreement with USFS**
2022	**FRB Catalyst Facility launched** **USFS MOU Renewed**
2023	**Blue Forest Asset Management launched** **Rogue Valley FRB launched**

BLUE FOREST

What is the Forest Resilience Bond?



The FRB is an innovative public-private partnership that deploys private capital to ease cash flows and add new revenue streams to fund forest restoration

- The FRB was developed in partnership with the World Resources Institute (WRI), the USDA Forest Service, and the National Forest Foundation (NFF)
- Yuba I & II FRBs financing $29 million of restoration to protect 65k acres in CA's Tahoe National Forest
- $8 million Rouge Valley I FRB protecting 77k acres in Southern Oregon
- $200+ million pipeline of potential FRB projects across 8+ states to finance wildfire risk reduction

BLUE FOREST

Systems Level Approach

FRB financing is only part of the solution – sustainably increasing the pace and scale of restoration will require balanced support for the entire system

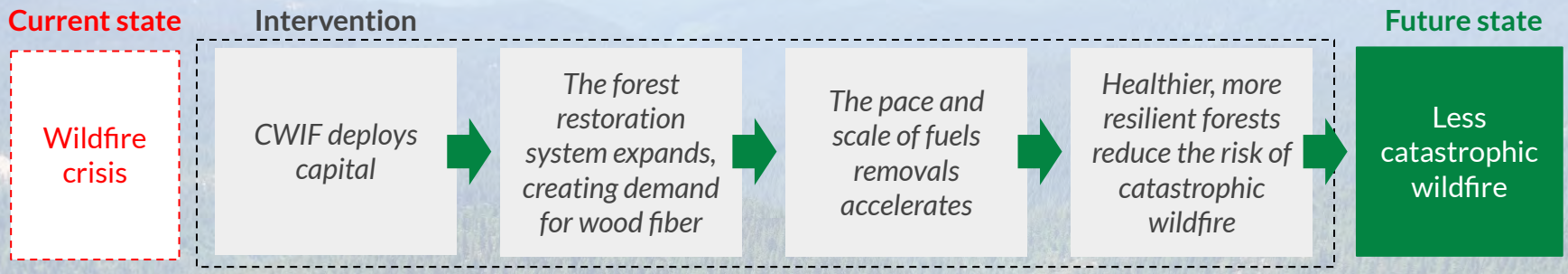
- Applied science and technical research
- Policy leadership and advocacy
- New partnerships and collaboratives
- **Investment in the restoration economy**

BLUE FOREST

I. ABOUT BLUE FOREST

II. CALIFORNIA WILDFIRE INNOVATION FUND I

California Wildfire Innovation Fund I



Investment Mandate	Generate competitive risk-adjusted returns while decreasing the severity and frequency of catastrophic wildfire in California
Fund Vehicle	10-year closed-end, commingled LP fund
Fund Size	First close of $25 million in February 2023
Anchor LP	CSAA Insurance Group, a AAA Insurer
GP	California Wildfire Innovation Fund I General Partner LLC, a subsidiary of Blue Forest Asset Management LLC
Deal Structures	Flexible tailored instruments with majority credit allocation

BLUE FOREST

Target Investments

Strategy	Targeting investments in forest restoration and wildfire management companies, with particular emphasis on: • Adding system capacity • Creating value for non-merchantable timber and biomass • Improved carbon outcomes
Sectors	• Forestry contracting and trucking • Wood products (specialty and commodity) • Biochar • Bioenergy • Biofuels • Cellulosic innovation (e.g. building materials) • Forestry and climate tech
Structures	Various types of debt and equity, including senior, mezzanine, and working capital loans; and structured equity investments
Investment size	Typically ~$2-5 million
Co-investment	Leverage public grant funding, sector financing, and private co-investment network
Value add	Seeking to align CWIF investments with Blue Forest's FRB project pipeline and industry network to create wood supply partnerships

BLUE FOREST

Value-added Investment for Companies

Business Need	Blue Forest Value Add
Specialized Capital	• **Industry specialization** provides unique sector expertise, business advisory and synergistic networking • **Partnership-based investments** with high-touch engagements and tailored terms, vehicles and timelines to support companies and projects
Supply Certainty	• **Local project insight** into funding, expected implementation treatments; close partnerships with implementation partners • **Strong relationships with federal and state agencies and policymakers** that manage forest restoration projects and funding
Government Partnership	• **First investment partner to sign an MOU with the USDA Forest Service**; 7+ year collaborative relationship • **High-level advocacy and policy visibility:** contributor to the Wildfire Emergency Act
Industry Network	• **Strong cross-sector relationships** with local collaboratives, forestry supply chain businesses, environmental non-profits, Tribes, communities and other stakeholders offer opportunities to exchange learnings and best practices and create synergistic partnerships • **Local access and trust** following years of discussion of capital needs with underbanked Northern California communities; often the first investor many stakeholders meet
Scientific Expertise	• **In-house research expertise** and dedicated science advisors; 5 PhDs with expertise in forestry, hydrology, carbon and economics • **Established external partnerships** with groups such as the World Resources Institute and the National Forest Foundation

BLUE FOREST CONSERVATION

Strategic Partnership Opportunities

Blue Forest is excited to build a community of practitioners and collaborate with diverse partners as we support and invest in the restoration economy

- **General inquiries about CWIF**: please contact *bfam@blueforest.org*
- **Investments - projects & businesses**: please contact Forest Crandall at *forest@blueforest.org*
- **Strategic organizational alignment with Blue Forest**: contact Zach Knight at *zach@blueforest.org*

BLUE FOREST

Forest Crandall
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