



California
Energy Commission
Research & Development

From Waste to Resource:

Advancing Technologies for Energy Generation from
Agricultural Wastes

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Energy Research and Development Division

Central Valley Summit on Alternatives to Open
Burning of Agricultural Waste
November 8, 2017. Parlier, CA





Topics

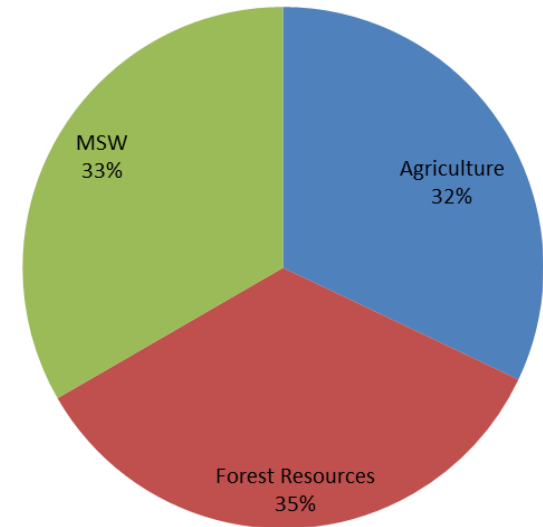
- ❑ An Overview of Resources and Energy Potential
- ❑ Policies Driving Increased Conversion of Agricultural Wastes
- ❑ Tree Mortality and Implications to SJV Agriculture
- ❑ Alternatives: Portfolio of Bioenergy Projects and Technologies
- ❑ Energy Commission's RD&D Programs Supporting Conversion of Woody Biomass
 - EPIC Program
 - Natural Gas R&D Program



Biomass Resources in California

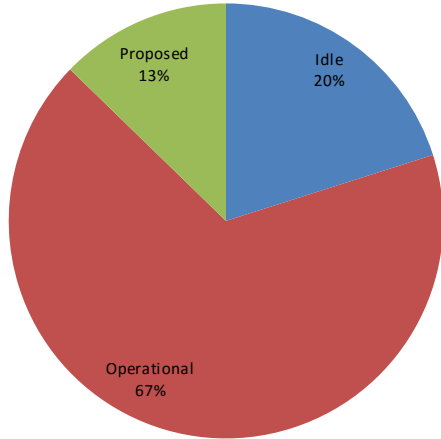
- Gross resource – 78 million bone dry tons per year (BDT/y)
- Biomass considered to be available on a technically sustainable basis – 35 million BDT/y
- Gross electrical generation potential = **9,900 MWe**
 - **Agriculture** – 2,300 MWe
 - **Forestry** – 3,500 MWe
 - **MSW** – 3,900 MWe
- Biogas potential from animal manures, landfill gas, anaerobic digestion of food, leaves and grass from MSW disposal stream, and wastewater treatment plants = **93 billion cubic ft/year**
- Report from CEC-funded Resource Assessment with California Biomass Collaborative, UC Davis. Published March 2015

Biomass Resources by Type

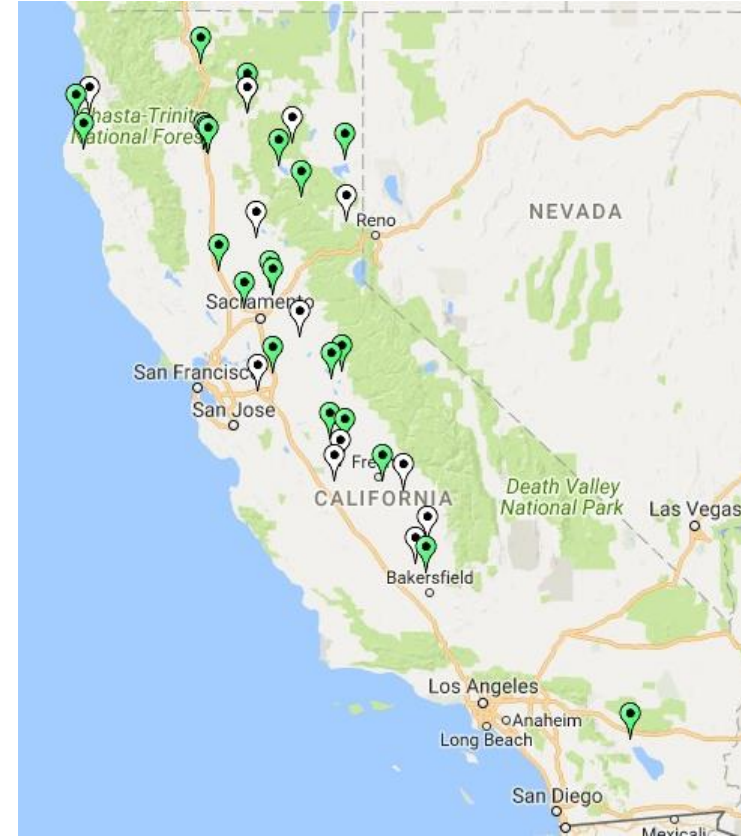


Bioenergy Facilities in California

Net Capacity by Project Status (MW)



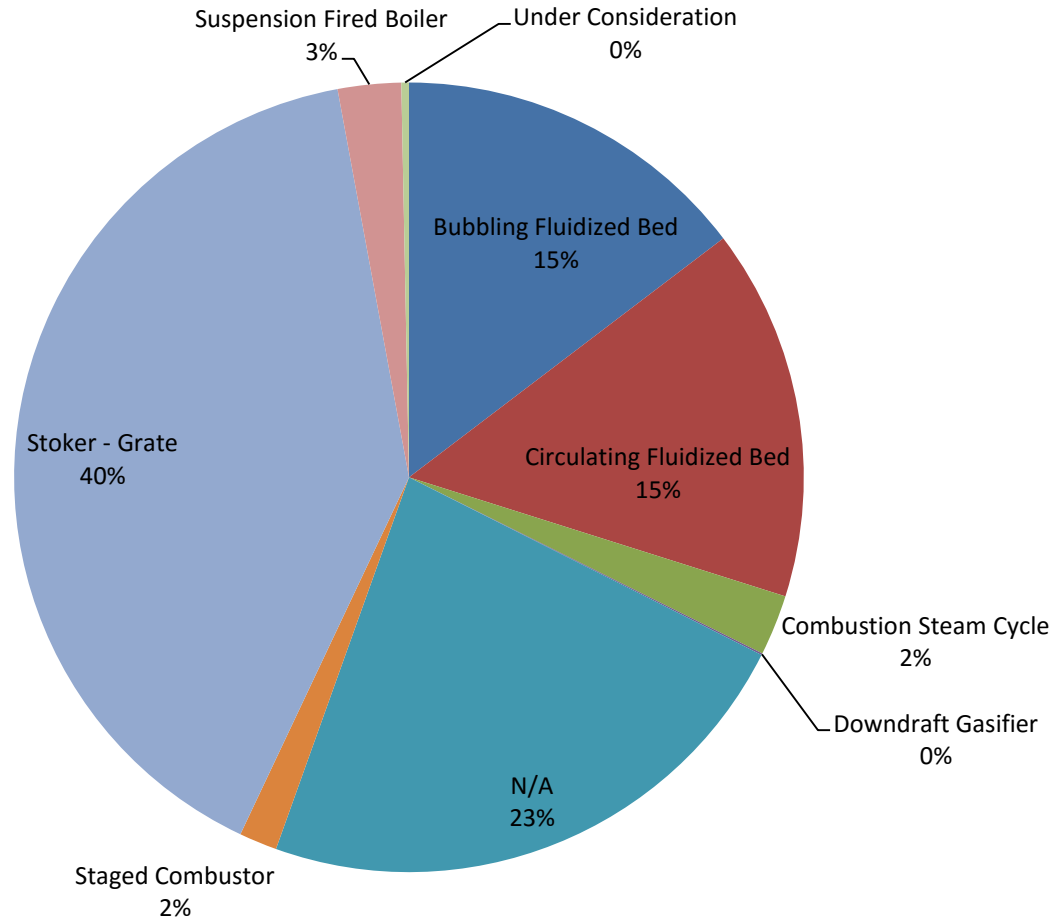
Status	Gross Capacity - MW	Net Capacity - MW
Idle	264.85	194.05
Operational	725.90	648.60
Proposed	50	123
Total	1040.75	965.65



- Currently 34 operating solid fuel biomass power plants in 19 counties
- Source – California Biomass Energy Alliance

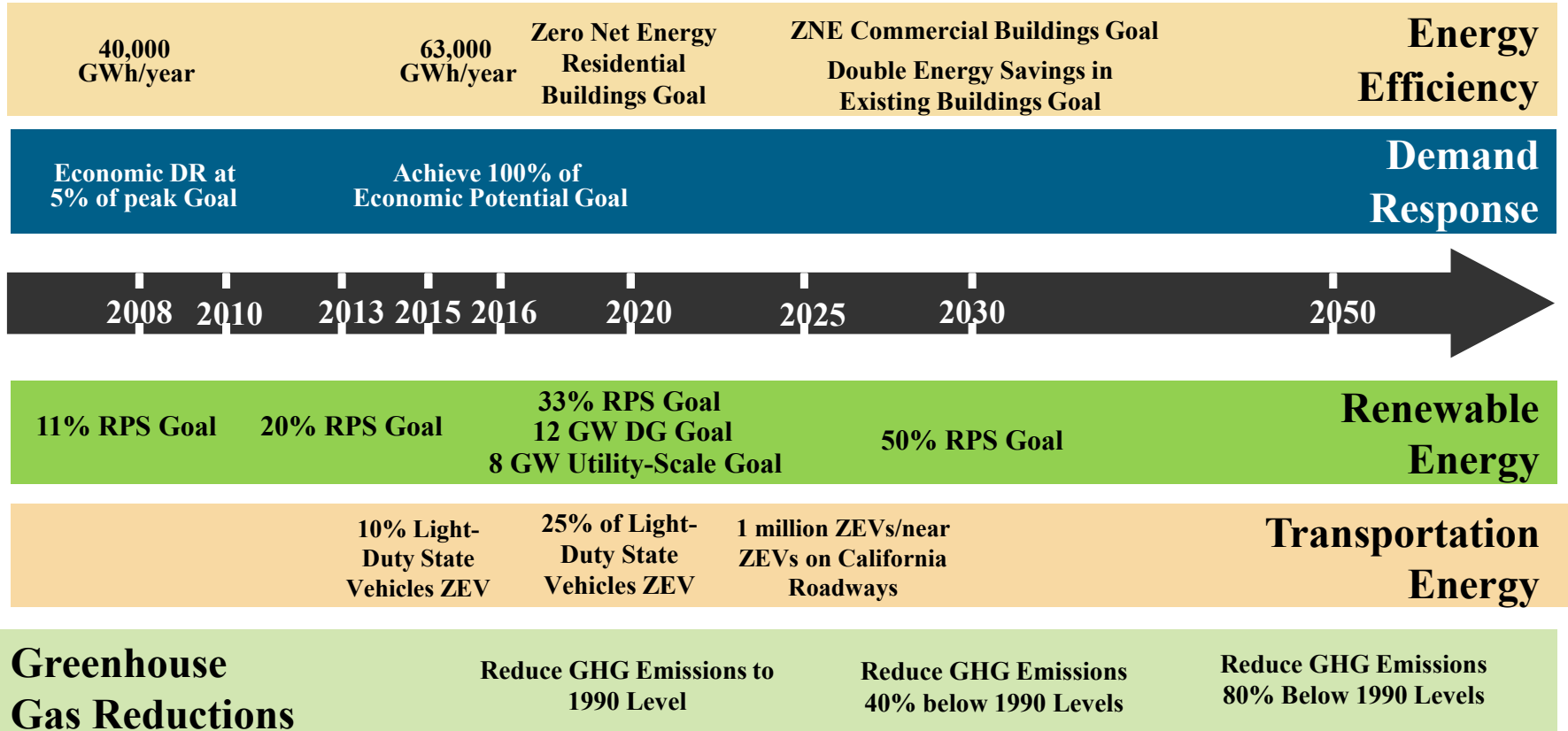


Biomass Facility by Technology Type





State Energy Policy Drives Energy RD&D Investments





Some Key Policies Driving Biomass Development

SB 1122 – Bioenergy Feed-in Tariff (Rubio, Chapter 612, Statutes of 2012).

- Bioenergy Market Adjusting Tariff (BioMAT)

Investor-owned electric utilities to collectively procure at least 250 MW of eligible renewable energy from small-scale bioenergy projects with capacities of 3 MW or less.

Category 1: Biogas from wastewater treatment, municipal organic waste diversion, food processing, and co-digestion - **110 MW**

Category 2: Dairy and other agricultural bioenergy - **90 MW**

Category 3: Bioenergy using byproducts of sustainable forest management (including fuels from high hazard zones effective February 1, 2017) - **50 MW**

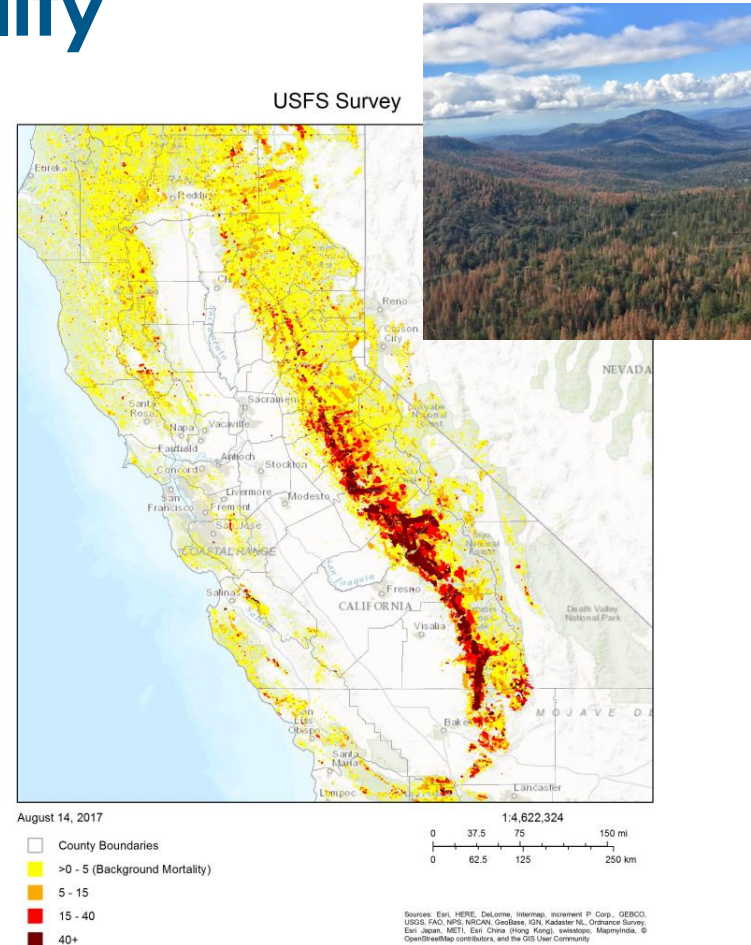
- Available Contract Price for each of the four Fuel Resource Pricing Categories set at \$127.72/MWh

AB 1923 (Wood) – BioMAT required 3 MW of capacity from bioenergy resources (increased to 5MW)

Tree Mortality

Per Governor's 10-30-2015 Proclamation of a State of Emergency, the CPUC was directed to:

- Utilize its authority to extend contracts on existing forest bioenergy facilities receiving feedstocks from high hazard zones
- Take expedited action to ensure that contracts for new forest bioenergy facilities that receive feedstock from high hazard zones can be executed within six months
- And prioritize facilitation of interconnection agreements for forest bioenergy facilities in HHZ, and order the use of expedited mediation or other alternative dispute resolution processes when conflicts delay development of projects





Alternatives: Portfolio of Bioenergy Technologies



Broad Range of Biomass-to-Energy Research and Development Projects



Altamont Landfill LFG to LNG Project
(Source: Waste Management)



Dairy waste management (Various digester projects)



Gills Onion Energy System converts onion waste to energy. (Source: Gills Onion)



The UC Davis Renewable Energy Anaerobic Digester
(Source: UC Davis)



Brown Grease Processing System at San Francisco's Oceanside Wastewater Treatment Plant (Source: SFPUC)



Biodiesel Production System (bottom) at San Francisco's Oceanside Wastewater Treatment Plant (Source: SFPUC)



Community Power Corporation's BioMax 50 demonstrated in Winters, CA for almond shells (Source: CPC)



Renewable Natural Gas Production from Woody Biomass via Gasification and Fluidized-Bed Methanation

Goal: Reduce the costs of cleanup of producer gas and reduce the costs of methanation to generate RNG from thermal gasification of biomass.

Technology Summary:

- A fast-internally circulating fluidized bed (FICFB) gasifier is able to convert biomass to producer gas with a high efficiency (>70%).
- Methods for the measurement and cleanup of trace contaminants in the product gas to make it suitable for methanation.

Features and Benefits:

- Development of methods for cleanup of producer gas from gasification
- Biomethane enabling technology development will provide information on costs, technological development, efficiency, safety, and additional performance data
- Evaluation of the technical and economic feasibility of syngas to biomethane



Contractor: University of California, San Diego
Funding: \$1,000,000(PIER); \$237,000(Match)
Agreement No: PIR-14-023
Term: 6/30/2015 – 12/29/2017



Burney-Hat Creek Bioenergy

Technology Summary:

- Utilizes West Biofuels CircleDraft gasification technology
- Builds upon success of Modular Biomass Power Systems to Facilitate Forest Fuel Reduction Treatments (EPC-14-024)
- Advances the technology to community-scale

Features and Benefits:

- Power generation at full rated capacity = 2.88MW
- Capacity factor – greater than or equal to 75%
- Heat and biochar byproducts
- Forest biomass sourced from Tier I and Tier II HHZ with 22,000 BDT consumed per year
- Reduction in 1,516 MT CO₂e per year



Agreement: EPC-17-019

Contractor: Fall River Resource Conservation District

Funding: \$5,000,000 Match: \$5,000,000

Term: 10/18/2017-9/30/2019



Innovative Biomass Gasification for Sustainable Forest Management

Powerainer+: Multi-modal power and products gasification platform

Technology Summary:

- Increase of 150kW to 210-250kW Powerainer+ system
- New value streams of hot water and biochar production
- Development of a pre-combustion biochar offtake increases capacity for forest waste processing from 1100 to 2200 tons per year
- CHP module to increase energy conversion efficiency from 20% to 60%
- Boosts biochar production and carbon sequestration capacity from 56 to 235 tons per year

Features and Benefits:

- Lower cost than previous APL gasification systems
- Substantially reduces the LCOE of distributed gasification



Agreement: EPC-17-017

Contractor: All Power Labs

Funding: \$1,500,000 Match: \$750,000

Term: 10/30/2017-06/30/2020



Camptonville Biomass-to-Energy Project

3 MW_{net} biomass power plant that will include advanced low-emissions control technology to reduce NO_x, CO, and VOC emissions and a low-water consumption condenser.

Technology Summary:

- Consumption of up to 30,000 BDT per year of forest biomass
- Sourced within 50 miles of the pilot plant
- Prove that the technologies in an integrated system can be successfully demonstrated at the relatively small scale of 3 MW_{net}

Features and Benefits:

- Generate up to 23.7 GWh/yr of renewable electricity and recover up to 473,040 therms when operated as a CHP plant
- Reduces GHG emissions by 9,582 metric tons CO₂e per year
- Consumes 29 million gallons of water per year less than a conventional condenser technology, a 79% reduction.



Agreement: TBA

Contractor: ICF

Funding: \$4,999,830 **Match:** \$13,030,225

Term: 10/2017 – 10/2021



Biomass to Electricity: Pilot-Scale Testing Baseload Compared to Flexible Power

Goal: Testing of woody-biomass gasification, comparing: baseload power generation using a Solid Oxide Fuel Cell with Fischer-Tropsch liquids production used for fuel storage, and producing bio-crude liquids used for slow-speed engine and flexible power.

Technology Summary:

- Uses the input of pulse-combustion-power to drive a Jet Spouted Bed & Reformer
- Pulse-Detonation-Power input increases process-intensity and concurrently lowers parasitic-power consumption
- Accomplish gasification/reforming when operating below the ash fusion temperature

Features and Benefits:

- Intended for deployment by communities in the 3 MWe to 12 MWe range
- Confirming a cost of \$3,750 per kWh of installed-capacity based on a 300-ton/day modular system
- Confirming the LCOP of \$118/MWh, including a 10% return based on a 300-ton/day modular system



Agreement: EPC-17-012
Contractor: Taylor Energy
Funding: \$1,499,000 Match: \$0
Term: 10/18/2017 – 10-18-2021



CEC's Energy Research Drives Technology & Strategic Innovation to Meet the Challenges

Natural Gas R&D- \$24M/yr

- ▶ Energy Efficiency
- ▶ Renewable Energy & Adv. Gen.
- ▶ Pipeline Safety
- ▶ Environmental
 - ▶ Methane Leakage
 - ▶ Climate Adaptation and Infrastructure Risk Reduction
- ▶ NG Transportation

Electric Program Investment Charge - \$125M/yr

- ▶ Energy Efficiency & Demand Response
- ▶ Renewable Energy & Adv. Gen.
 - ▶ Smart Communities
- ▶ Smart Grid, Storage, DER
- ▶ Environmental
 - ▶ Climate Adaptation and Infrastructure Risk Reduction
- ▶ Electric Vehicle Grid Integration
- ▶ Market Facilitation

CEC Administered EPIC Funding



Funding Areas

- Energy Efficiency
- Clean Generation
- Smart Grid
- Cost Share for Federal Awards
- Renewables
- Demand Response
- Integration of EE, DR, DG and Smart Grid
- Cost Share for Federal Awards
- Entrepreneurial support and assistance
- Innovative local strategies
- Streamlined customer adoption



Bioenergy in the 2018-2020 EPIC Investment Plan

- Emphasis on the thermochemical conversion
- Technologies and strategies that reduce the LCOE
- Low-emission generation technologies, pollution control, and other technologies that can cost-effectively utilize low-quality biogas



FY 2017-18 Proposed Funding Initiative Specific to Biomass

❖ **Piloting Pipeline Quality Renewable Natural Gas from California's Forest Biomass Resources**

- Support pre-commercial technologies and strategies to enable economic conversion of forest waste biomass to RNG
- Possible technologies and strategies include:
 - A pilot-scale demonstration of woody biomass conversion to RNG and subsequent pipeline injection;
 - Improvements to the methanation reaction for cost-effective conversion of woody biomass-derived syngas to RNG;



Thank You!

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