Yreka, October 21 2010

Biomass to Electricity

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In partnership with:
USDA Forest Service Region 5

http://ucanr.org/WoodyBiomass

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Making a Difference for California

Biomass Energy – Some Rules of Thumb

- 1 MW (1,000 kW) is enough power for 800 to 1,000 homes.
- Biomass fuel is purchased on a Bone Dry Ton (BDT) basis.
- Typical amount of biomass recovered during fuels treatment is 10-14BDT/acre.
- Typical “burn rate” is 1 BDT/MW hr.
- 10MW plant consumes 10 BDT/hr.
- Assuming that 12 BDT/ac is recovered, a 10 MW plant would procure biomass from fuels treatment on approximately 7,000 acres/year.

Source: TSS Consultants

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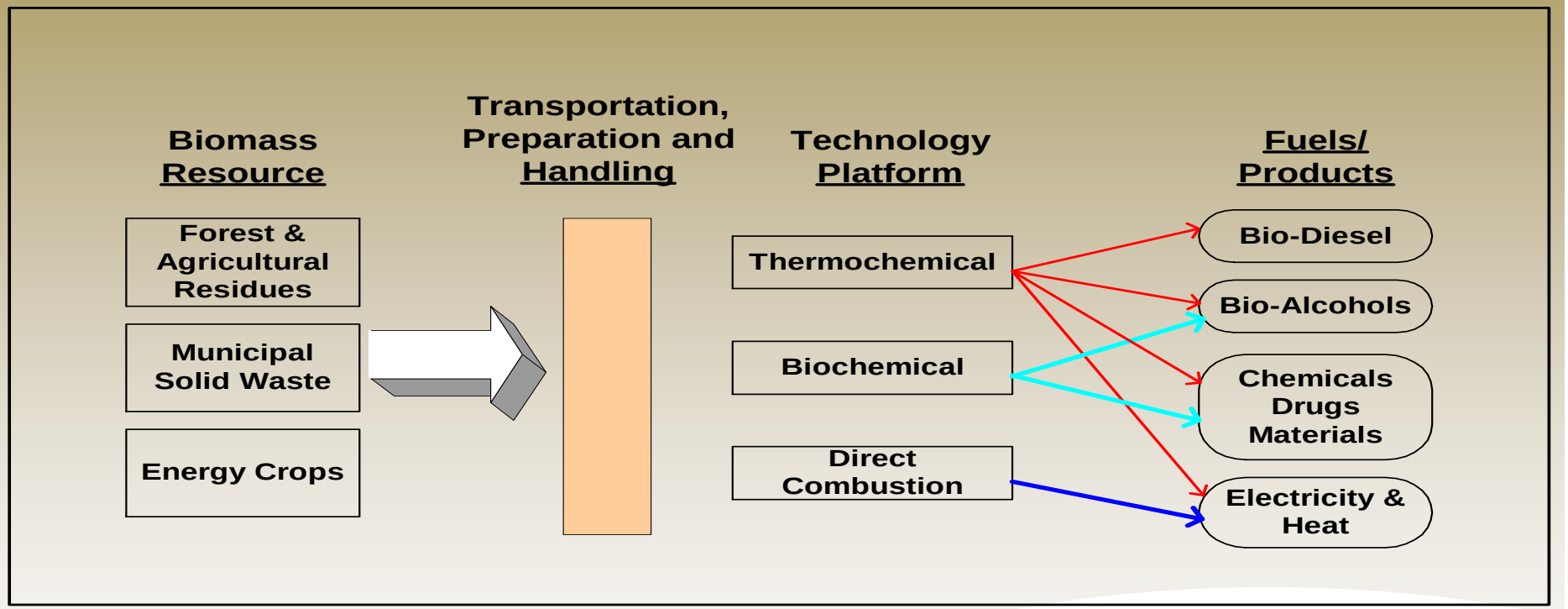
Advantages of Biomass Compared to Other Renewables

- Provides baseload renewable energy (24/7) on a cost effective basis.
- Has numerous societal benefits:
  - Supports hazardous fuels reduction and healthy forests
  - Provides employment ~4.9 jobs/MW (NREL)
  - Reduces waste material destined for landfills
  - Net improvement in air quality
  - Greenhouse gas reduction displacing fossil fuels

Conversion approach



Source: TSS Consultants

Biomass to electricity

Two main components:

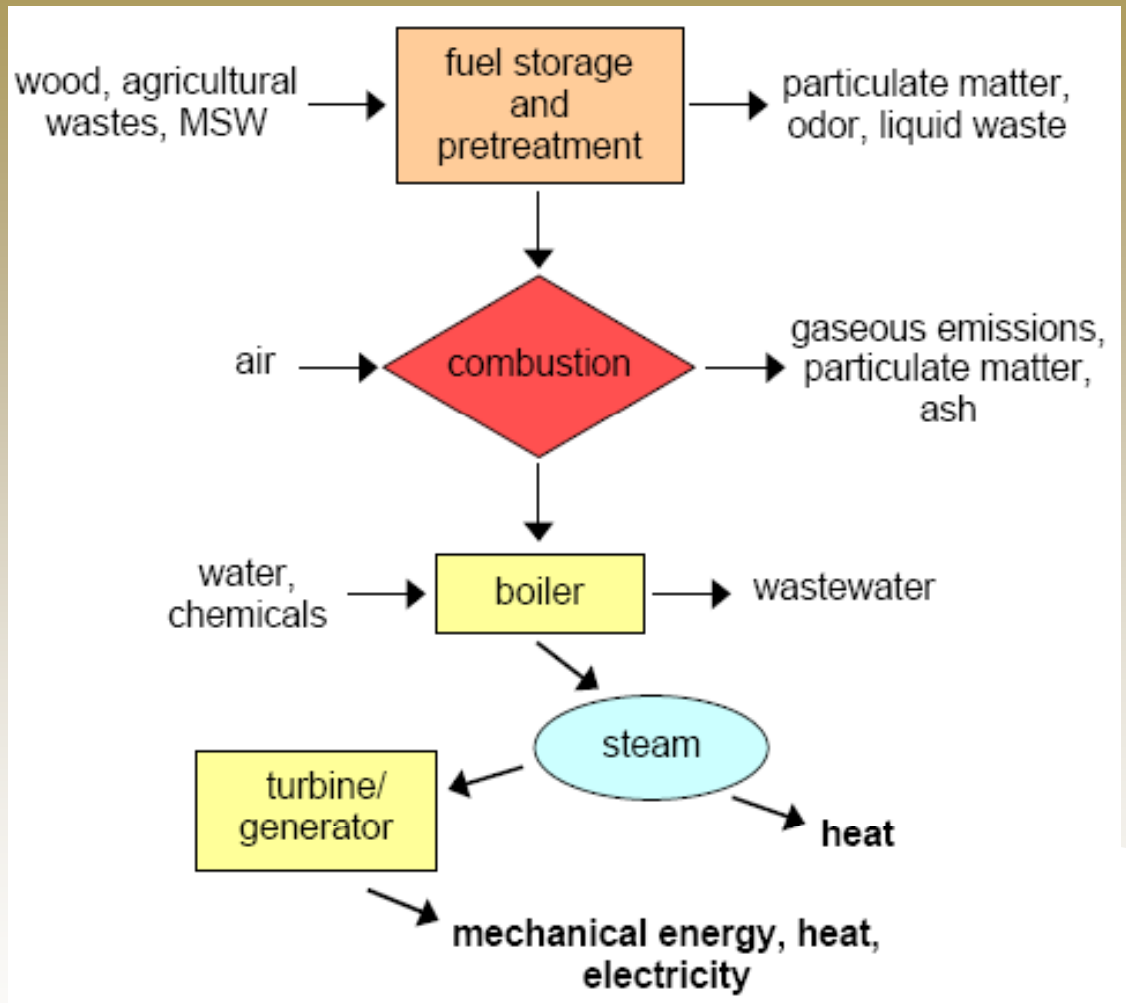
1. An energy conversion system that converts biomass to useful steam, heat, or combustible gases

2. A prime mover (turbine, engine, etc.) that uses the steam, heat, or combustible gas to produce power

Note: *Cogeneration or CHP is when you use the heat also*

Typical industrial system

Direct combustion to produce steam to run turbine generators



Source: TSS Consultants

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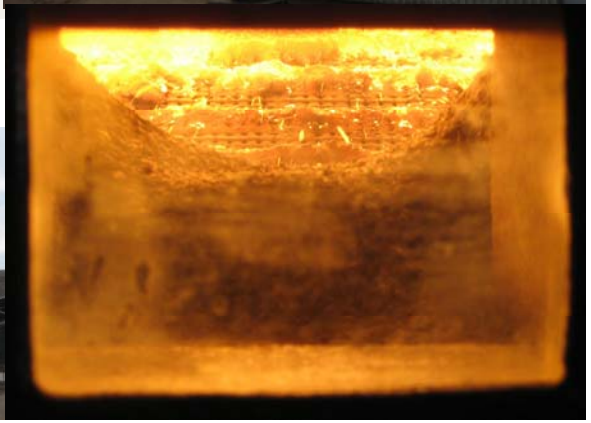
US biomass power plants

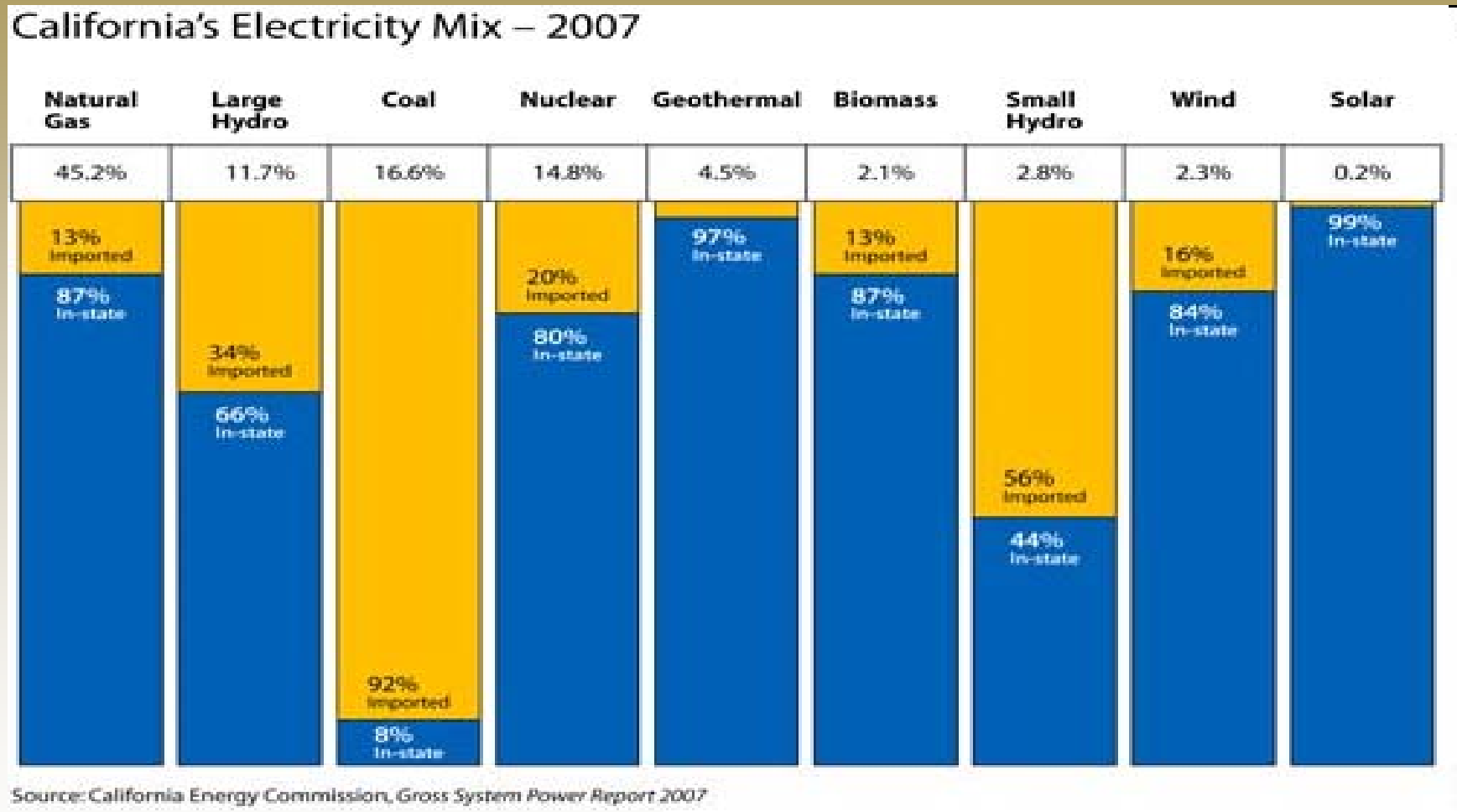
- 5-110MW (average 20MW)
- Installed cost $2000-$3500 per kW
- Most are combustion / steam turbine
- Most are grate stokers
- Smaller units cost more
- Advanced technologies cost more



Typical biomass power plant (20 MW)

- 20 MW plant provides electricity to 15-20,000 homes
- New plant construction cost = $60-$80 million
- Processes ~160,000-200,000 tons/yr (1BDT/MW/hour burn rate)
- Biomass transported up to 50 miles
- Delivered biomass valued at $15– 60/BDT
- Average production cost ~ $0.07 - $0.10/kWh
- Current PPA prices in CA $0.11/kWh+

Biomass to electricity in California



Source: California Energy Commission, *Gross System Power Report 2007*

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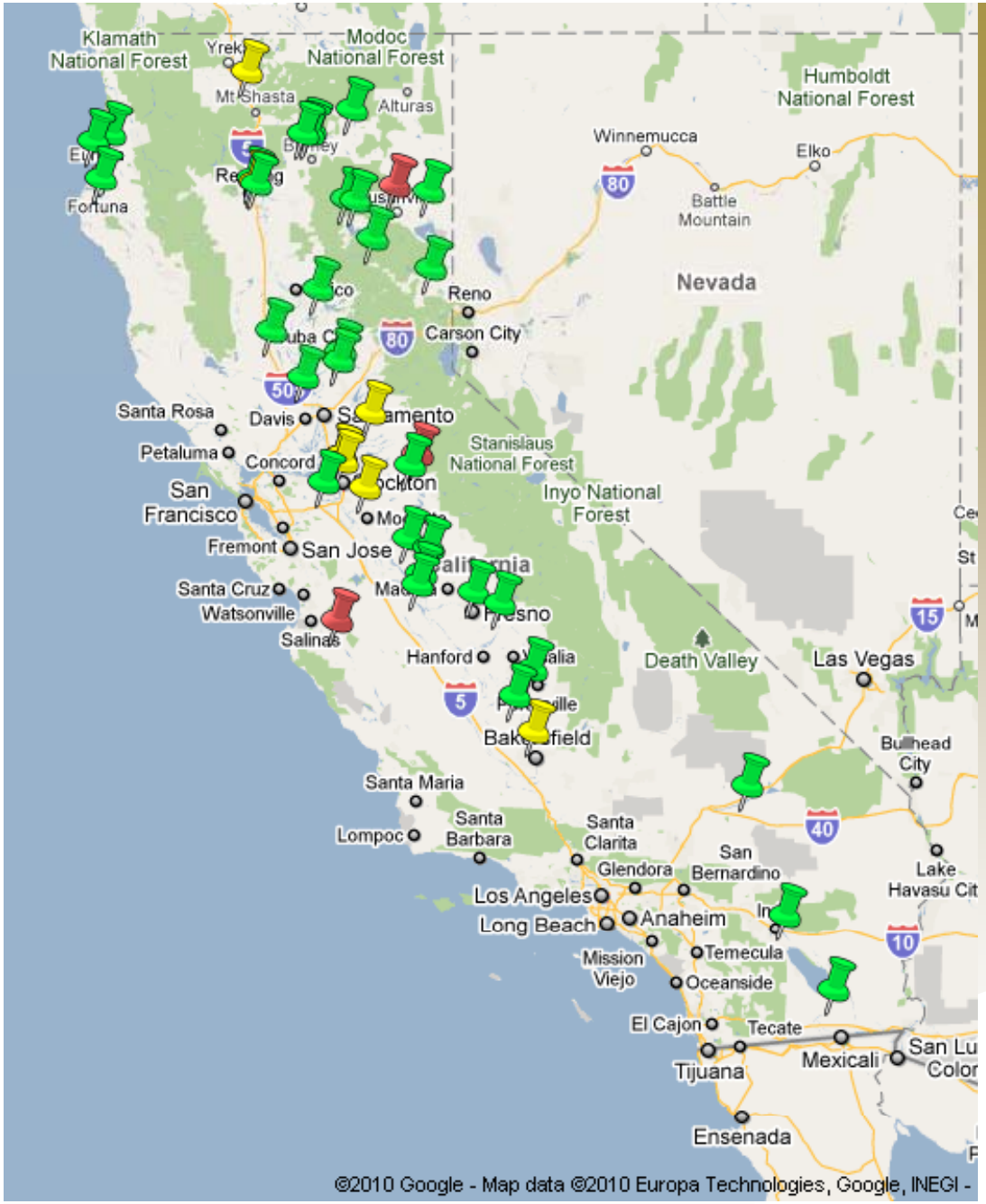

- ~ 32 plants in CA
- ~ 600MW capacity
- ~ 25% are CHP
- 3-50MW size
- Most facilities of any state

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Biomass Combustion Concerns

- Availability and cost of fuel
- Emissions
- Higher maintenance compared to other fuel types
  - Inorganic (ash) transformations lead to fouling of combustion chamber surfaces and slag formation on bottom
  - Increased corrosion from acidic gases
- Maintenance issues can lead to reduced capacity and efficiency

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Power Plant Efficiency

	Heat Rate (Btu/kWh)	Efficiency (%)
Natural gas combined-cycle	7,500	45.5
Coal-fired steam/electricity	10,000	34.1
Biomass-fired steam/electricity	15,000	22.7
Biomass-fired, combined heat and power (co-gen)	8,500	70.0

Source: John Shelly

Criteria for success

- Fuel supply
- Grid interconnection and electricity sale
- Financing

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Potential Customers

- Regulated utility (eg PG&E, SCE etc)
- Unregulated utility – Munis (eg SMUD), PUD's
- Forest products manufacturing facility (eg sawmill, veneer mill, pellet mill)
- Agricultural processing (eg dairy)
- Oilfields
- Others

- Customers for heat need to be local
- Customers for electricity can be anywhere on the grid

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The Future of Biomass Power Plants Depends on …

- Biomass utilization policies
- Relative price of natural gas and electricity
- Environmental issues
  - Emissions – particulates, CO_2
  - Carbon accounting -- does biomass CO_2 have a zero emission impact?
- Societal value placed on biomass disposal/use (e.g. reducing wildfire hazards)

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- Questions…

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