California Energy Commission
DOCKETED
13-IEP-1M
TN 71258
JUN 12 2013

STATUS OF AGRICULTURAL BIOMASS ENERGY IN CALIFORNIA

CEC Staff Integrated Energy Policy Report Workshop
Status of Bioenergy Development in California
Sacramento, CA

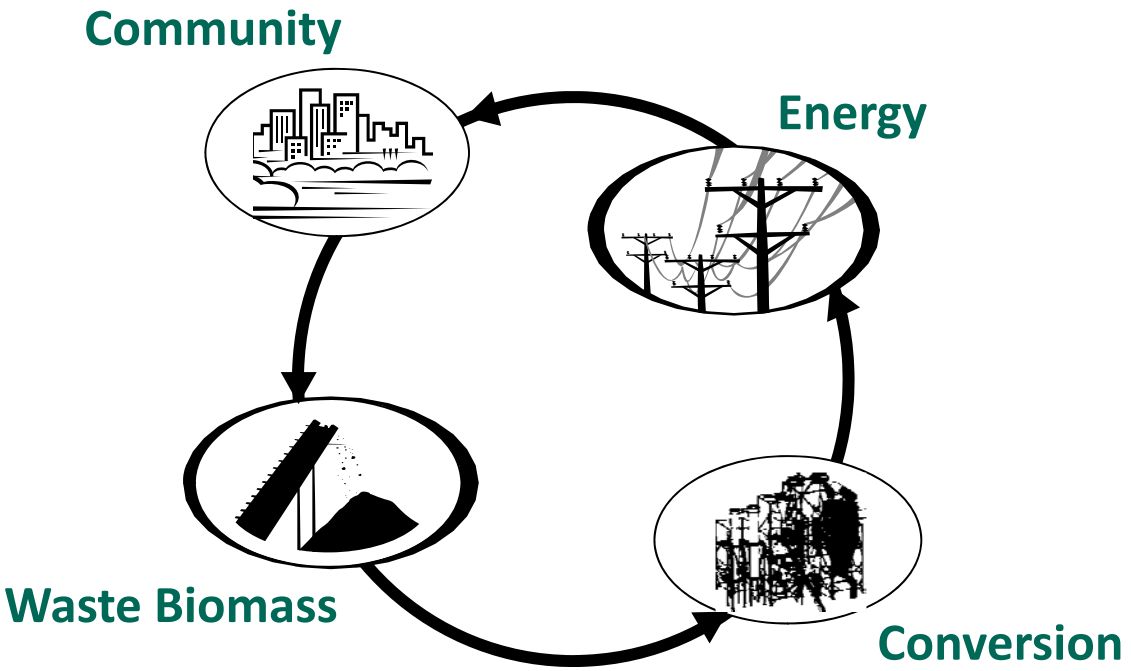
SUMMERS CONSULTING, LLC
ENERGY RESOURCES ENVIRONMENT

June 3, 2013

WESTBIOFUELS

BIOMASS ENERGY OPPORTUNITY

Energy production that helps us become energy independent, lower our carbon footprint, create local green jobs and foster economic growth.



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STATUS EVALUATION – DAIRY BIOGAS

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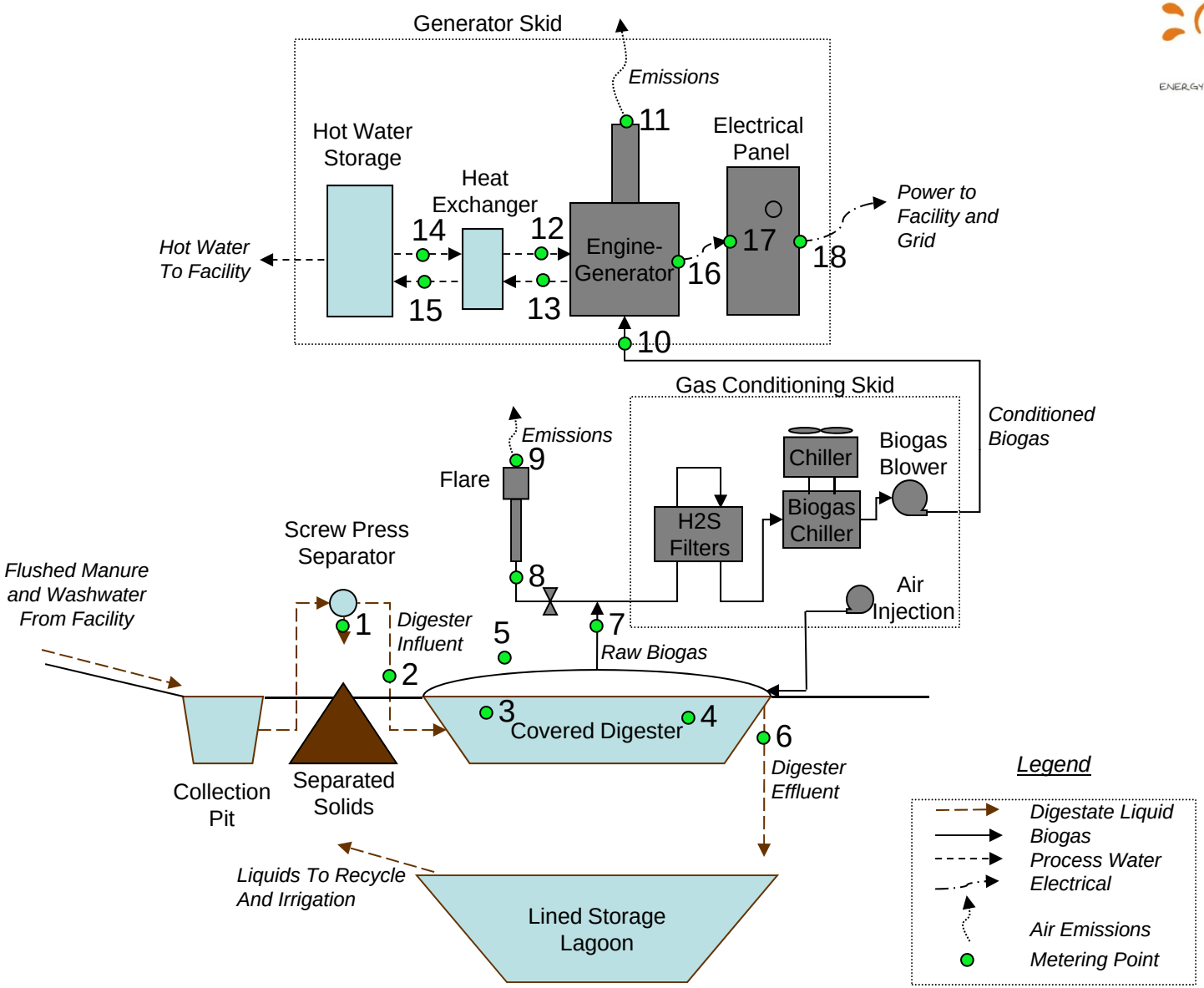
Facility Number	Size (cows)	Feedstock Type	Digester Type	Biogas Use
0 (Not included in project, ceased operation in 2009)	5200	Flush Manure	Covered Lagoon	Pipeline Gas (250K CFD)
1	250	Flush Manure	Covered Lagoon	Power (65 kW)
2	300	Flush Manure	Covered Lagoon	Power (75 kW) Heat Recovery
3	5000	Mixed	Covered Lagoon	Power (750 kW) Heat Recovery
4	1800	Flush Manure	Hybrid Lagoon	Power (229 kW) Heat Recovery
5	1800	Mixed	Complete Mix	Power (710 kW) Heat Recovery
6	1400	Scraped Manure	Plug Flow	Power (190 kW) Heat Recovery



Typical Dairy Digester System

SUMMARY OF RESULTS – DAIRY BIOGAS

- Anaerobic digester systems reduce the dairy manure solids by:
  - 29-62% within digester
  - 52-76% with entire system (including solids separation)
- Manure stabilized in terms of oxygen demand and biomethane potential
- Nutrients are conserved in these systems
- Nitrogen converts towards ammonia form which is more crop available
- Methane emissions from dairy manure reduced by 60-70%
- Combined heat and power genset performance on biogas
  - 21-28% Electrical Efficiency (LHV)
  - 21-38% Heat Recovery Efficiency (LHV)
  - 42-66% Overall CHP Efficiency (LHV)
- Capacity factors:

  >80% - 2 systems; 50-80% - 2 systems; <50% - 2 systems

CALIFORNIA OPPORTUNITY – DAIRY BIOGAS

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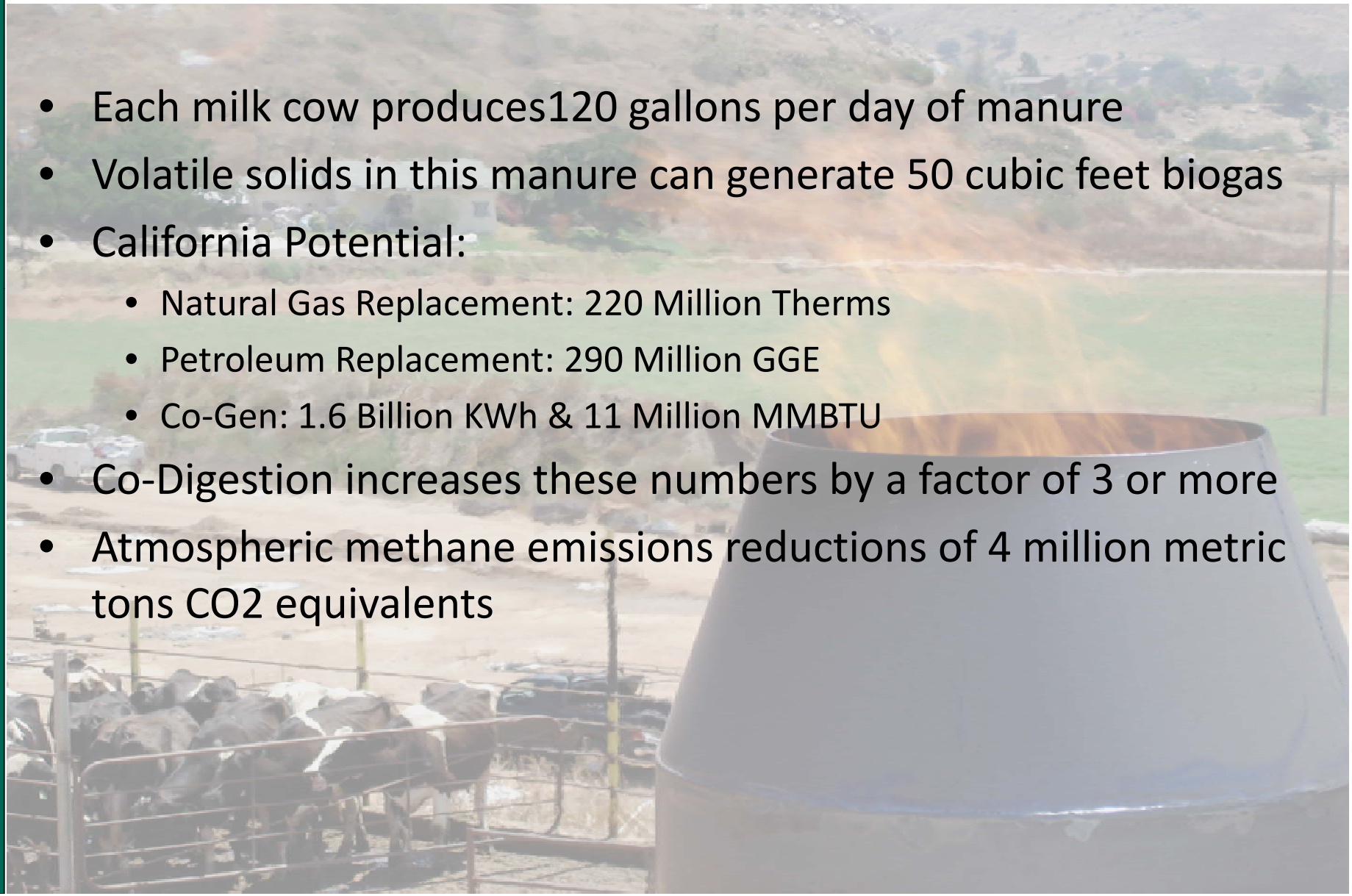
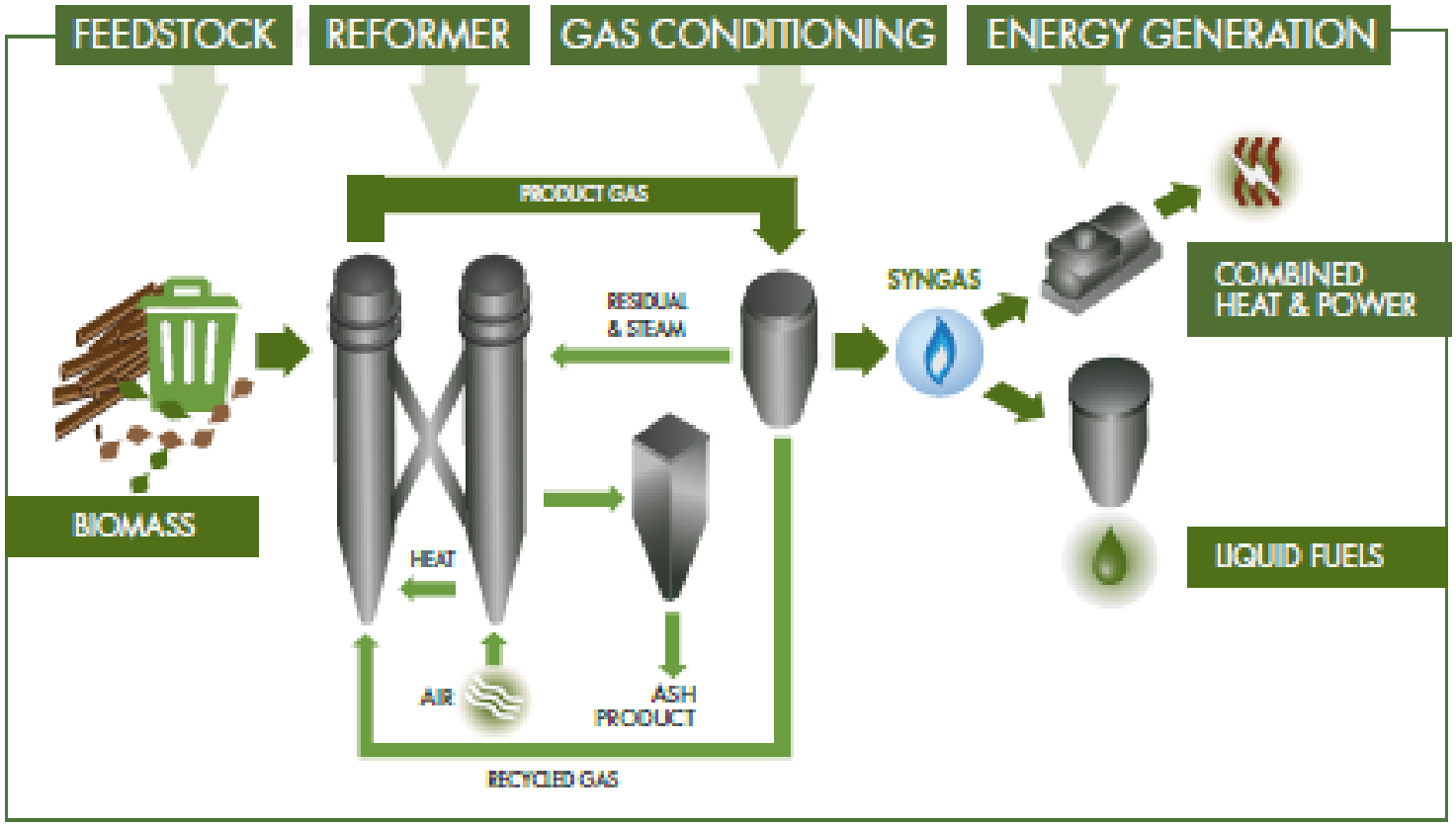


- Each milk cow produces120 gallons per day of manure
- Volatile solids in this manure can generate 50 cubic feet biogas
- California Potential:
  - Natural Gas Replacement: 220 Million Therms
  - Petroleum Replacement: 290 Million GGE
  - Co-Gen: 1.6 Billion KWh & 11 Million MMBTU
- Co-Digestion increases these numbers by a factor of 3 or more
- Atmospheric methane emissions reductions of 4 million metric tons CO_2 equivalents

ECONOMIC CHALLENGE – DAIRY BIOGAS

Dairy	Capital Cost (20 year payback) in Terms of kWh Production	Operating and Maintenance Cost in Terms of kWh Production	Total Costs to Produce Power	Actual Utility Rates Received
Dairy 1	$0.273	$ 0.034	*$0.307*	*$0.109*
Dairy 2	$0.120	$ 0.037	*$0.157*	*$0.062*
Dairy 3	$0.046	$ 0.032	*$0.078*	*$0.103*
Dairy 4	$0.227	$ 0.064	*$0.291*	*$0.058*
Dairy 5	$0.096	$ 0.040	*$0.136*	*$0.110*
Dairy 6	$0.073	$ 0.044	*$0.117*	*$0.062*

THERMAL CONVERSION – AG RESIDUES



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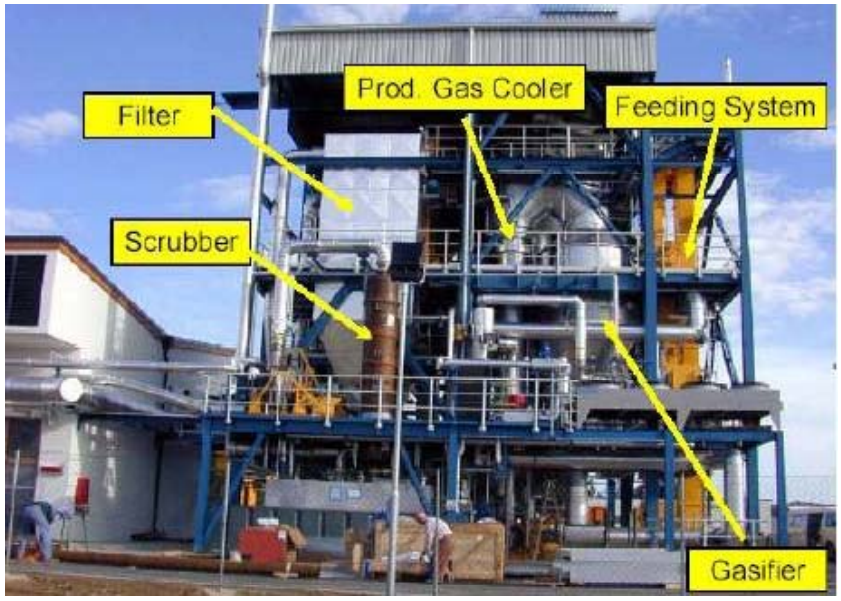
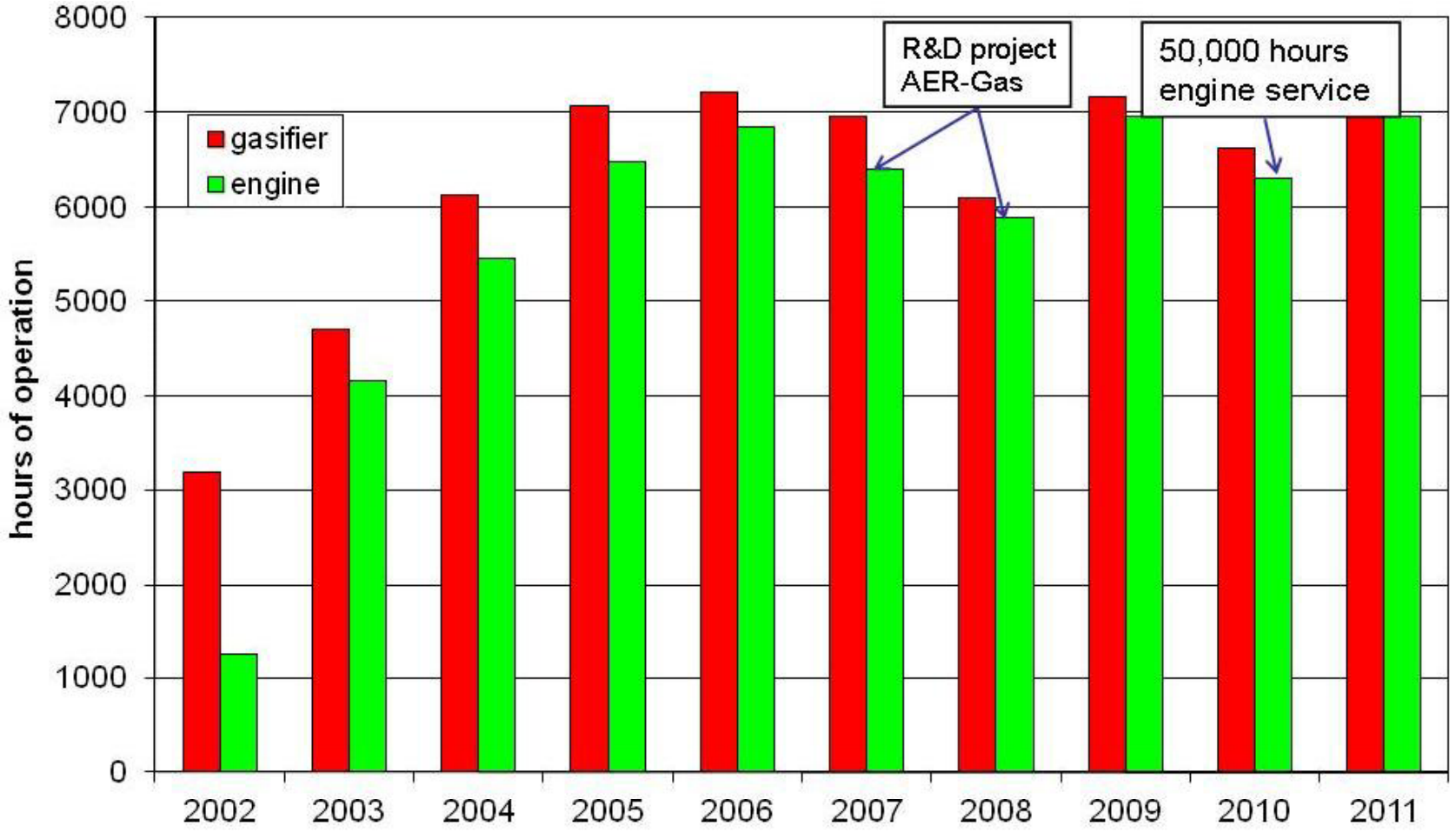
WORKING MODEL

Biomass Combined Heat and Power Plant – Gussing Renewable Energy, Gussing, Austria

- Fuel Capacity 8 MW, Electrical Output 2.4 MW, Heat Output 4 MW
- 81.3% Thermal Efficiency on wood residue
- District heating system - 300 homes, 50 offices, school and hospital with electricity sold to grid
- Fast internally circulating fluidized bed
- Successful liquid fuel and synthetic natural gas demonstrations
- Excellent environmental performance
  - Low gaseous emissions
  - No liquid emissions
  - 5% or less ash residue



West Biofuels has selected this technology for development in North America



Biomass Combined Heat and Power Plant-Gussing, Austria

Fuel Capacity, 8 MW, Electrical Output 2 MW

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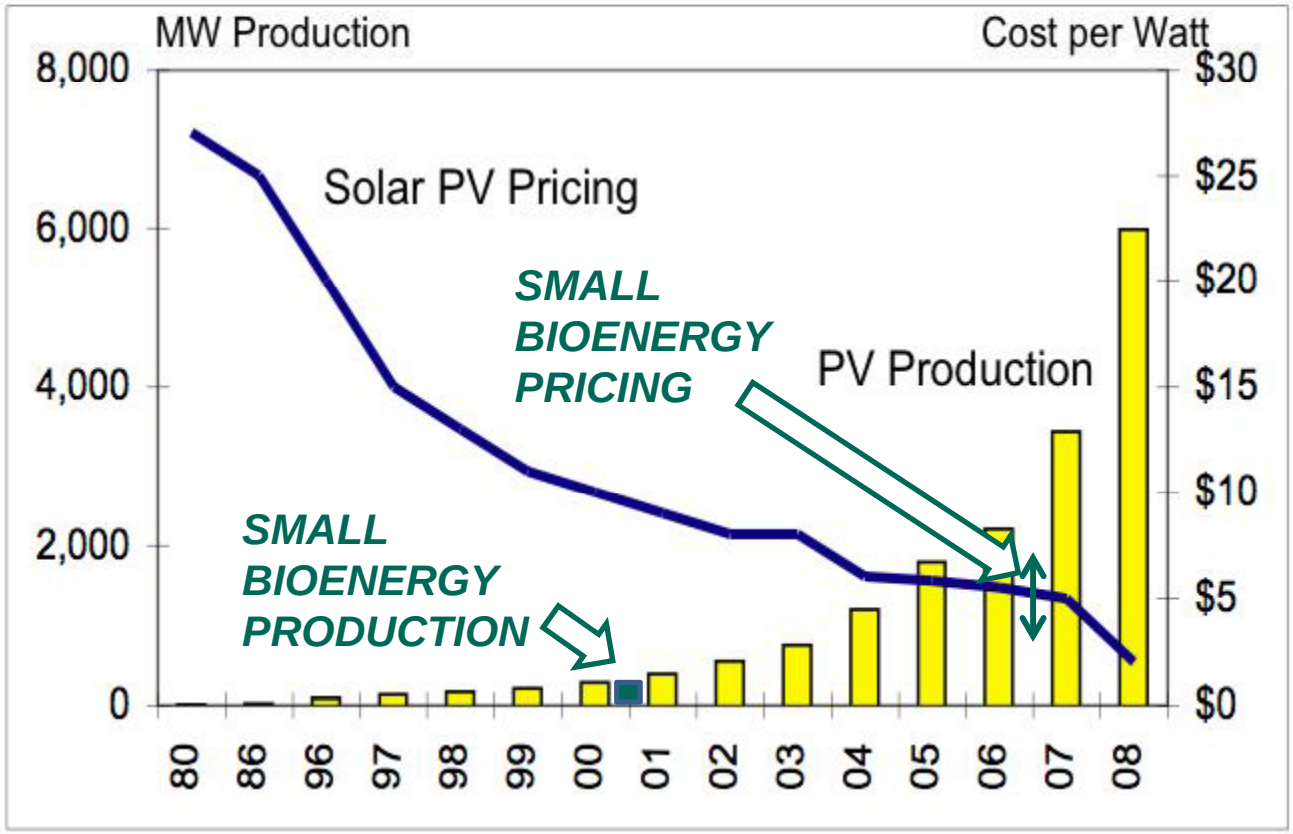
MARKETS ARE WHAT DRIVES DOWN COSTS

Solar PV Global Production and Cost per Watt



Source Solar Buzz, Company reports,, Green Econometrics research

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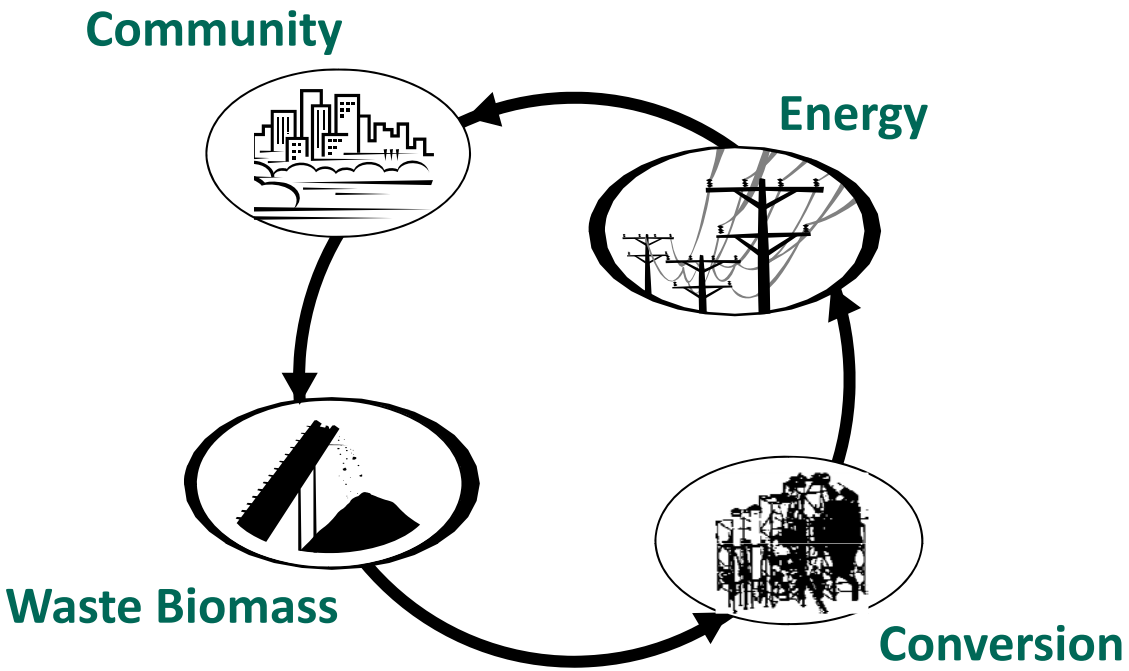

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