

Opportunities and Challenges for Biogas & RNG Projects in SMUD Territory

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2 Day Conference & Exhibition

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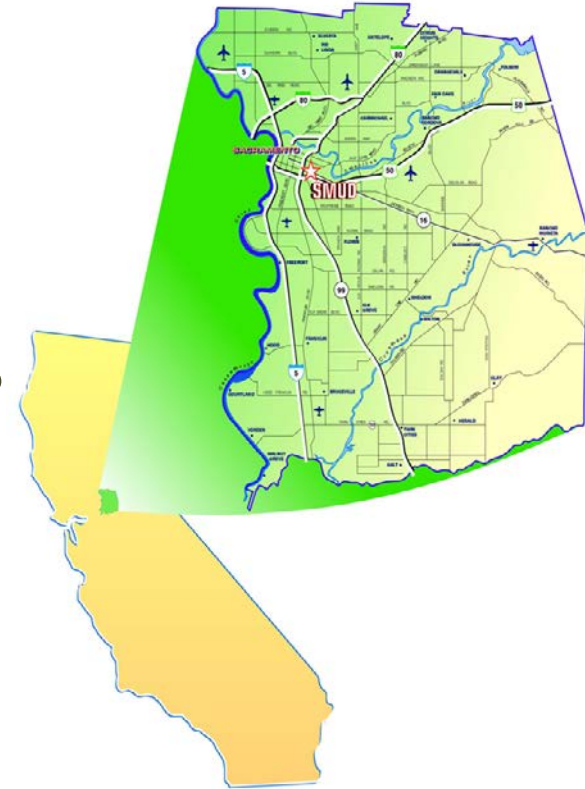


Outline

- About SMUD, Policy, Vision
- Biomass Program Vision
- Opportunities
 - Drivers & Benefits
 - Biomass Resource Potentials
 - Current Status
 - Where we want to be?
- Challenges
- Biogas and RNG Projects
- Final Remarks

SMUD – Owned By Customers

- Not for Profit, Publicly Owned Utility
- Sacramento County (small part of Placer County)
- Almost 600,000 Customers; 1.4 Million Population
- Record Peak Demand = 3,300 MW
- 5th Largest in CA and 6th Largest in the U.S
- **7 Member Board of Directors**
 - Elected by Ratepayers
- Not a Part of the City or the County
- Manage Balancing Authority in Northern California (BANC)
- Low Rates, Innovative & Green
- Generation: 25% Hydro; 29% Renew. 46% Efficient Gas (Cogen, Comb. Cycles, Peakers)
- **1st in customer satisfaction survey for the last 14 consecutive years (J.D. Power & Associates Survey)**



Key Board Policies for R&D Program

SD 10 R&D: To assure SMUD's long-term competitiveness and its ability to deliver innovative products and services, SMUD shall invest in research and development projects that support its core and key values, based on an analysis of the projects' relative risks and their potential benefits to SMUD customers.

SD 9 Resource Planning:

90% Reduction in GhG emission by 2050

1.5%/yr. EE Goals

Renewable Supply: 12% 2006; 24% 2010; 37% 2020

SD 2 Affordability, SD 4 Reliability, SD 7 Environmental Leadership

SMUD's Biomass Program

Vision Statement

SMUD's vision is to have an affordable, reliable, and sustainable biomass industry that:

- empowers our customers,
- captures environmental benefits, e.g. reduces greenhouse gas emissions, reduces odor
- produces renewable biopower,
- lowers costs,
- co-produces value-added products, and
- creates economic opportunities across the SMUD's region.

SMUD's Biopower: Affordable, Reliable, and Sustainable Power Supply

The collage illustrates the biomass energy process. It includes a large industrial facility, a diagram of a biomass-to-energy conversion system, a pile of wood chips, a field of trees, a cow in a field, a pile of food waste, and a solar panel array. The SMUD logo is in the bottom right corner.

SMUD

SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.™

Benefits - Why Biomass?

Benefits	Strategic Directives (SD) Being Addressed
<ul style="list-style-type: none"> Producing local renewable & green energy for electricity production, combined heat and power (CHP) and pipeline injection applications. 	SD 1B, SD-7, SD-9, SD 10 , SMUD 3.0 North Star, DES, ER&D Strategic Plan
<ul style="list-style-type: none"> Reducing GHG emissions and destroying methane that otherwise would be vented and contribute to global warming. 	SD-7, SD-9, SD 10 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Improving waste management (for manure wastes) for forest health, timber stand improvement or implementation of best manure management practice. 	SD-7, SD-9, SD 10 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Reducing odor and flies for livestock operation. 	SD-7, SD-9, SD 10 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Improving local air quality by reducing emissions of volatile organic compounds (VOCs). 	SD-7, SD-9, SD 10 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Producing steady revenue source for the developer through electricity sales lease agreements for farmers. 	SD-1B, SD-13 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Co-producing heat and other value-added products for new agricultural markets such as fertilizer or soil amendment – from biochar or digestate. 	SD-7, SD-13 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Promote economic development by creating jobs and tax revenues. Economically revitalizing agriculture and rural communities. 	SD-13 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Improving DG and local grid support. 	D-9, SD 10 , SMUD 3.0, North Star, DES and ER&D Strategic Plan
<ul style="list-style-type: none"> Reducing catastrophic wildfires for urban and forest interface, improve forest health, watershed and timber stand, reduce costs of forest management, reduce risks and improve public health and safety. 	SD 1B, SD-7, SD-10, SD 13 , SMUD 3.0, North Star, DES and ER&D Strategic Plan

Opportunities (Barriers/Challenges)

Why isn't development occurring as expected despite of benefits?

Institutional (biggest reason)

- State environmental policies and program are fragmented & sometimes conflicting
- Arduous & complex permitting process
- Limited public awareness of the benefits of biogas & biomass gasification-methanation (RNG)

Economics

- High costs
- Low prices of natural gas
- Financing is difficult

Technical

- NOx
- Biomass gasification-methanation remain to be fully demonstrated and commercialized
- New biomass developments viewed to have some technical risk
- Lack of commercial success and data for new & emerging technologies
- Utility interconnection/transmission

Environmental

- Environmental benefits are not internalized
- Catastrophic wildfire threat

Environmental Leadership: Key SMUD EE & Renewables Goals

- SMUD’s Board of Directors adopted aggressive energy efficiency goals – 15% over ten years. **The most aggressive utility energy efficiency goals in the state.**
- **Aggressive Renewable Energy Goals**

Renewable Energy Program	2009 Actual	2010 Goal	2010 Actual	2020 Goal
RPS	18.8%	20%	20.4%	33%
Greenergy	3.5%	3.8%	3.8%	4%
Total	22.3%	23.8%	24.2%	37%

What Is Driving Biogas & RNG?

- **Meet SMUD & ER&D Vision, Mission & Plan**
- **GHG regulations**
 - ✓ Reshaping energy supply
 - ✓ Prompting biomass energy developments
 - ✓ Climate change
- **RPS-driven energy additions**
 - ✓ Distributed Generation & Bulk Power Generation
 - ✓ Pipeline injection
 - ✓ Utilizes existing transmission pipeline infrastructure
 - ✓ Local biomass development
 - ✓ Biogas development
- **Other Environmental Concerns**
 - ✓ **Local and problem wastes**
 - ✓ Health and Safety Issues
 - ✓ Reduce Air & Water Emissions (NO_x, H₂S, PM etc)
- **Loss of Energy Resources**
 - ✓ Power & Thermal
 - ✓ Additional revenue stream for agricultural and other sectors
 - ✓ Productive use of organic waste materials
 - ✓ Transportation fuels

Agriculture

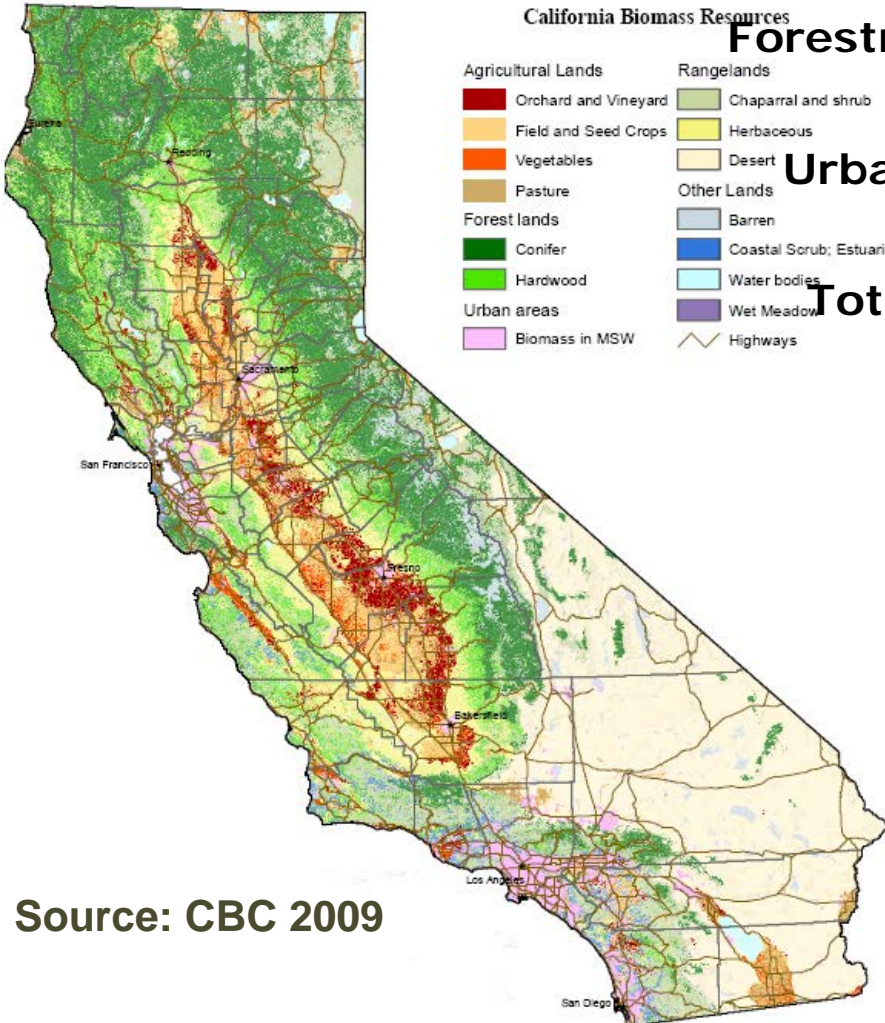
Forestry

Urban

Total

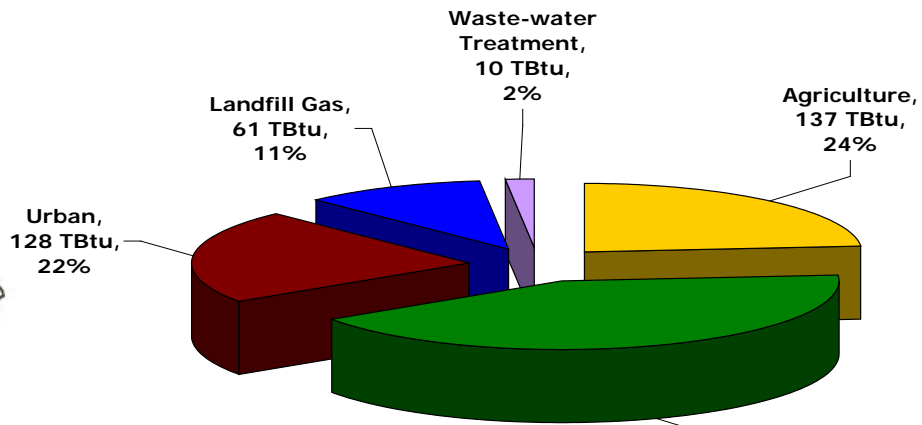
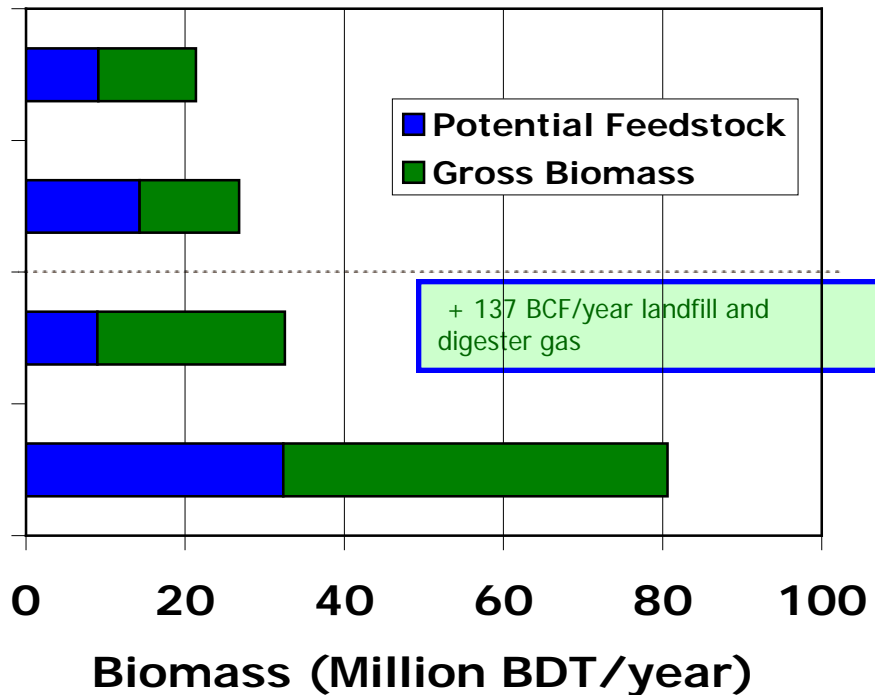
California Biomass Resources

- | | |
|--|---|
| Agricultural Lands | Rangelands |
| ■ Orchard and Vineyard | ■ Chaparral and shrub |
| ■ Field and Seed Crops | ■ Herbaceous |
| ■ Vegetables | ■ Desert |
| ■ Pasture | Other Lands |
| Forest lands | ■ Barren |
| ■ Conifer | ■ Coastal Scrub; Estuarine |
| ■ Hardwood | ■ Water bodies |
| Urban areas | ■ Wet Meadow |
| ■ Biomass in MSW | — Highways |



Source: CBC 2009

Data sources: CDF FVEG 2002 Version 2
DWR Land Use 1994 - 2004, National Land Cover Data, 2002



Potential Feedstock Energy in Biomass
507 Trillion Btu/year

California Biomass Resources



Biomass Energy Conversion Pathways



Biomass Resources

- Agricultural Residues (Livestock Manure, Food Wastes, etc.)
- Forestry Residues
- Municipal Solid Waste
- Wastewater

Processing & Handling

- Separation
- Processing
- Handling
- Transportation

Conversion Processes

- **Thermochemical** (Combustion, **Gasification**, Pyrolysis)
- **Biochemical** (Anaerobic Digestion, Fermentation, Direct Hydrogen)
- **Physicochemical** (Oil Extraction, Hydrocarbon Extraction)

Gas Cleaning Upgrading

- ↓
- Particles
 - Tar, organics
 - Sulfur, H₂S
 - NO_x
 - CO₂

Utilization

BioPower:

- Electricity
- Heat
- **CHP & CCHP**

Pipeline Gas (RNG or biomethane)

Biofuels:

- Ethanol
- Biodiesel
- Methanol
- Hydrogen
- **SNG**
- **CNG**
- Pyrolysis Oil
- Others

Bioproducts & Chemicals

SMUD's Biomass Potentials

Sacramento County – for years 2010 and 2020

	2010	2010	2020	2020
Conversion Pathway	Gross Potential (MW)	Technical Potential (MW)	Gross Potential (MW)	Technical Potential (MW)
Thermochemical	200	61	259	69
Biochemical	26	11	28	12
Total MW	226	72	287	81

Source: CBC 2008

Biomass Potentials –

Adjacent and outlying counties of Sacramento includes Amador, Calaveras, Colusa, Contra Costa, El Dorado, Nevada, Placer, San Joaquin, Solano, Stanislaus, Sutter, Yolo, and Yuba Counties

	2020
Conversion Pathway	Technical Potential (MW)
Thermochemical	898
Biochemical	96
Total MW	994

Source: CBC 2008

Biogas Potentials in CA & Western US (Resource Potentials for Pipeline Gas)

	California	Other 12 Western States	Total
	Gross MW*	Gross MW*	Gross MW*
Wastewater Treatment Plants	210	351	561
Landfills	1300	990	2,290
Dairy Manure Digesters	470	566	1,036
TOTAL	1,980	1,907	3,887

* All analysis assumes a heat rate of 6900 BTU/kWh for conversion of biogas to power

12 Western states: Washington, Oregon, Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, New Mexico, Oklahoma, and Texas.

Source: B&V & SMUD 2010, A case of biogas for pipeline Injection
(excluding food wastes, FOG, and other organic wastes for co-digestion or stand-alone AD)



Where we want to be?

SD 9 Resource Planning:

90% Reduction in GhG emission by 2050

1.5%/yr. EE Goals

Renewable Supply: 12% 2006; 24% 2010;
37% 2020

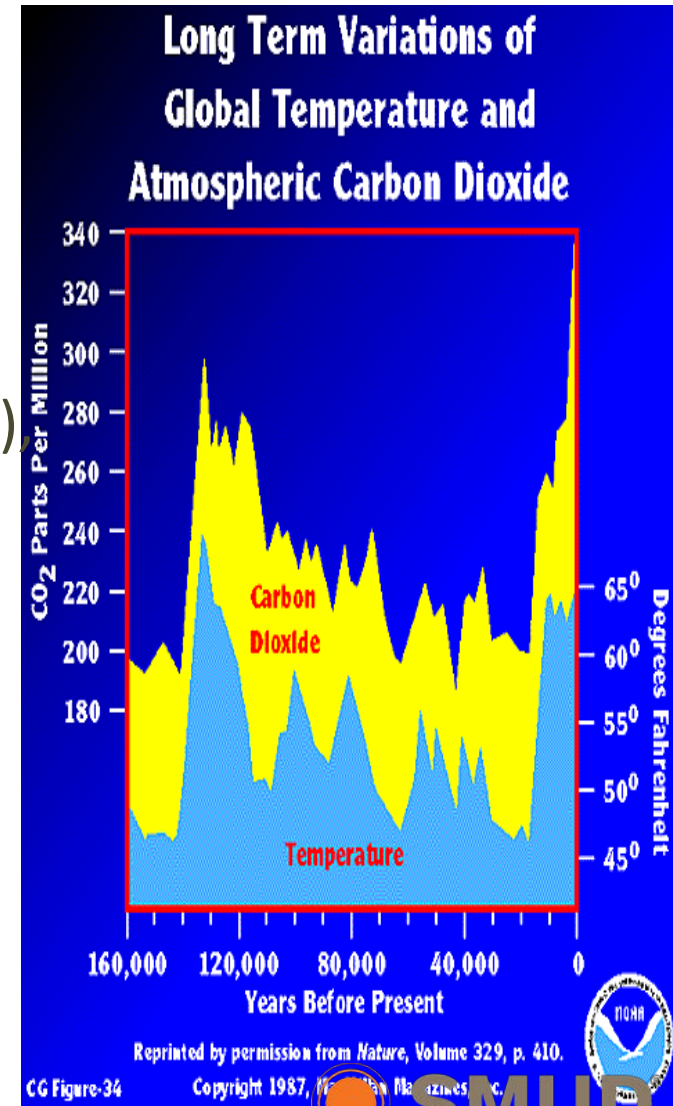
SD 2 Affordability

SD 4 Reliability

SD 7 Environmental Leadership (clean & safe)

Sustainable Power Supply Goal

- Sustainable Power Supply reduces SMUD's long-term *greenhouse gas emissions from generation of electricity to 10% of its 1990 carbon dioxide emission levels by 2050* (<350,000 metric tonnes/year) while *assuring reliability of the system; minimizing environmental impacts* on land, habitat, water quality, and air quality; and *maintaining a competitive position* relative to other California electricity providers.

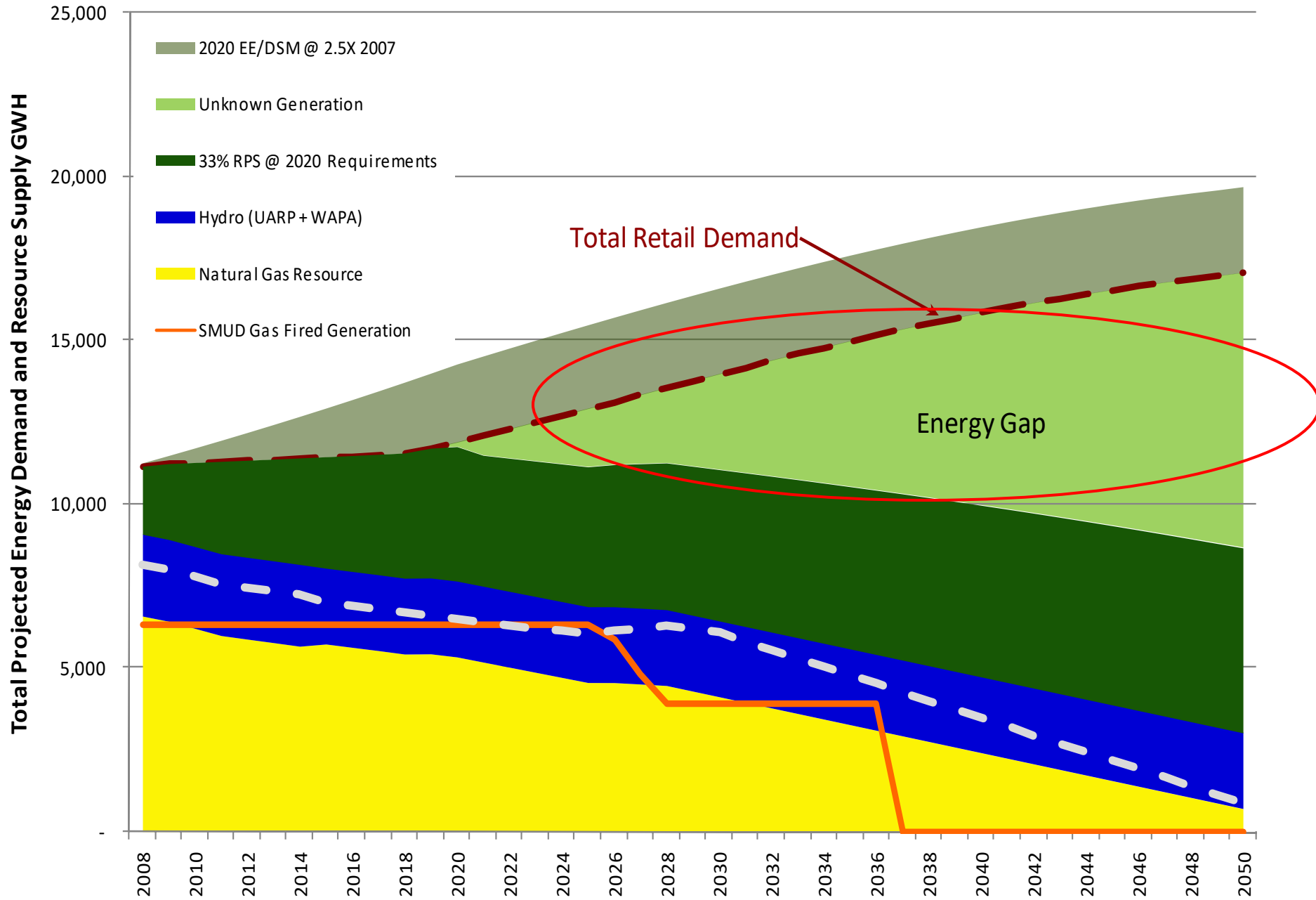


2050 LOAD CHALLENGES

“Possible Scenario”

- Thermal/Carbon emitting - ~10%
- Large hydro - ~15-20%
- Other non-carbon resources - ~70-75%
 - Renewables (37% by 2020)
 - New demand-side/energy efficiency programs
 - Carbon sequestration
 - Other non-carbon generation
 - Purchasing carbon offsets

SMUD Projected Resource Mix Through 2050



Addressing The Gap

- Actions that reduce GhG emissions
 - Energy Efficiency (Existing & Future)
 - **Renewable Energy (Existing & Future)**
 - Carbon Sequestration & Recycling (Future - R&D)
 - Carbon Offsets (Future - Regulatory)
 - **Research, Development & Demonstration (RD&D)**

Where are we?

“Current Status”

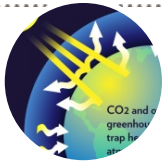
SMUD Renewables Goals

- Aggressive renewable energy goals

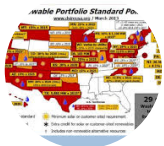
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RPS	18.8%	20%	20.4%	33%
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Biomass Program Accomplishments

(Biomass Strategic Values for SMUD/Customers)



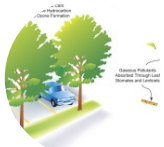
Largest contributor to SMUD's GHG Reduction Program



Largest Contributor to RPS (49% in 2015)



Significant Contributor to Local DER (263 GWh ~ 20% of biomass in 2015)



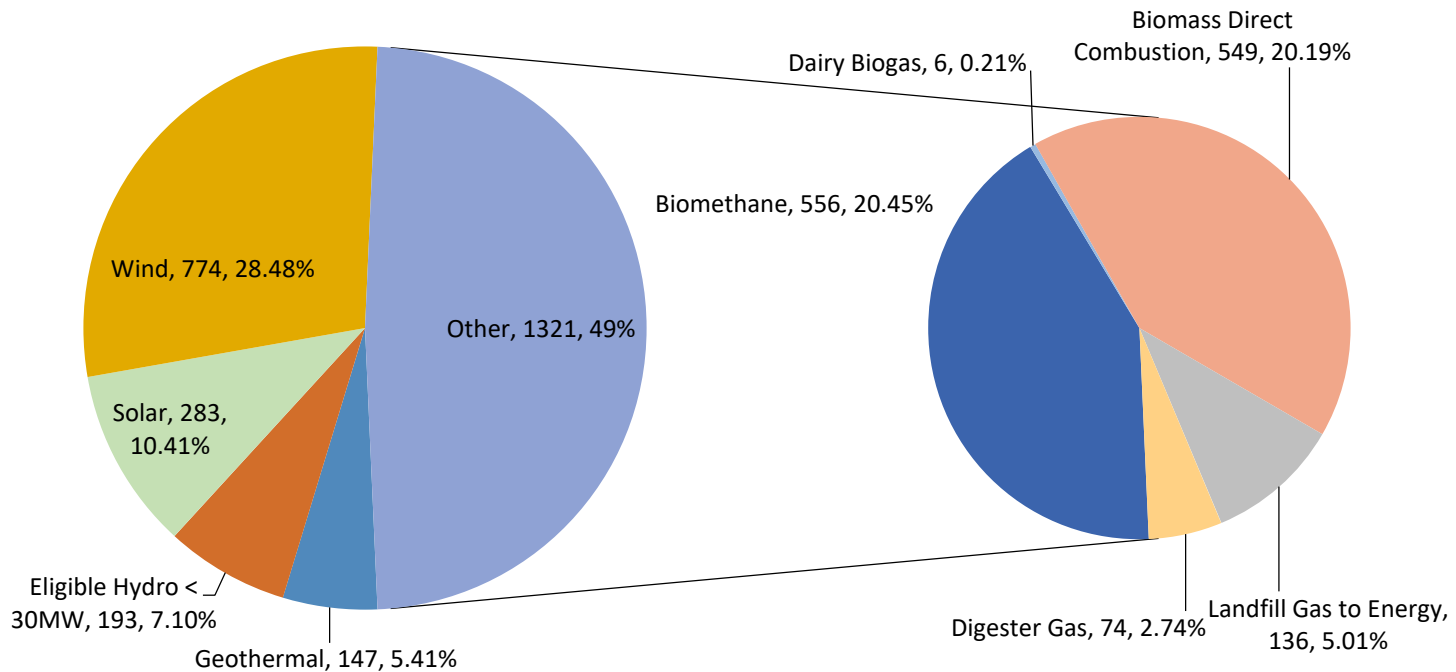
Major Contributor to Reduction in Criteria Pollutants



Significant Growth in Diversion of Local Problem Wastes (dairy wastes, urban wastes, ag wastes, regional forest waste)

SMUD's Renewable Mix

SMUD's RPS Supply by Resource Type
2015 (est.)



Biomass Projects

Biomass-Derived Methane Gas



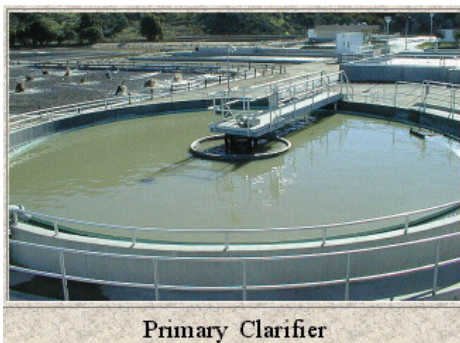
Landfill Gas From Landfills



Digester Gas From AD of Food Wastes



Biogas From AD Livestock operations



Primary Clarifier

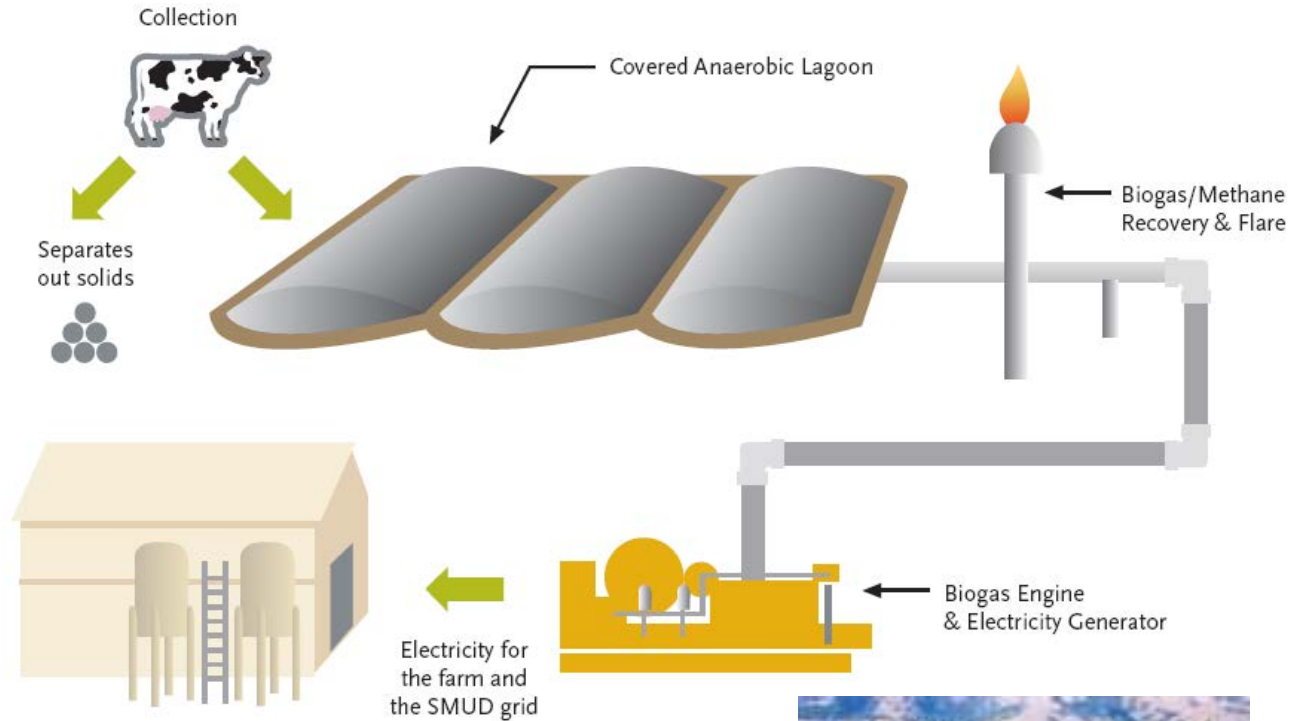
Digester Gas From AD of Wastewater Treatment Plants

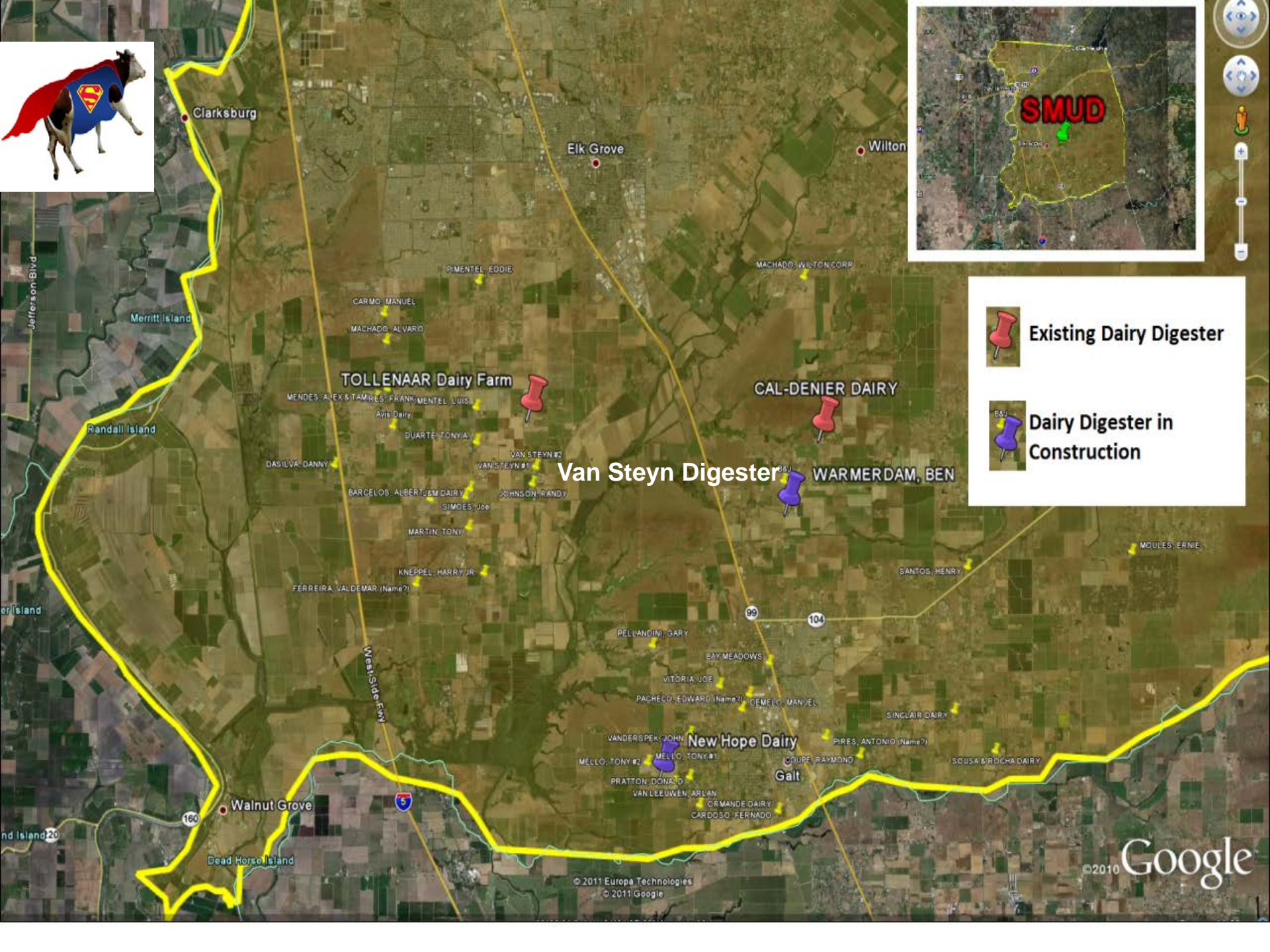


Producer Gas or Syngas From Gasification of Biomass ?

Dairy Biogas to Energy

SMUD is working with local dairies to capture methane from cow manure to generate electricity





Existing Dairy Digester



Dairy Digester in Construction

Van Steyn Digester

TOLLENAAR Dairy Farm

CAL-DENIER DAIRY

WARMERDAM, BEN

New Hope Dairy

Clarksburg

Elk Grove

Wilton

Merritt Island

Randall Island

Walnut Grove

Dead Horse Island

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SMUD Community Renewable Energy Development Project



- Award from USDOE AARA (\$5,000,000), CEC (\$500,000)
- 4 projects



- Simply Solar
- County Wastewater Treatment Plant - Co-Digestion of Fats, Oils & Grease Waste and other liquid wastes

Community Renewable Energy Deployment

Grants: \$5,050,000 (DOE) & \$500,000 (CEC)

• Under construction

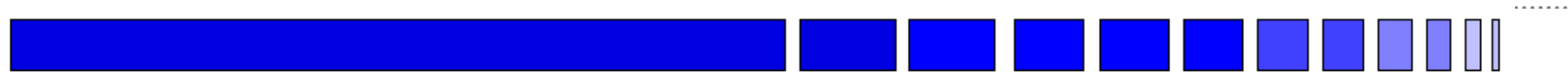
- ◆ Solar Solar at the Sutter's Landing R
- New Hope Dairy Anaerobic Digester
 - ◆ Co-Digestion of Fat, Oil, Grease Waste
- Warmerdam Dairy Anaerobic Digester



- ◆ Beginning construction
- ◆ Anaerobic Digester at New Hope Dairy
- ◆ Anaerobic Digester at Van Warmerdam Dairy



SMUD Community Renewable Energy Development Project



- Award from USDOE AARA (\$5,000,000), CEC (\$500,000)
- 4 projects
 - Simply Solar
 - County Wastewater Treatment Plant - Co-Digestion of Fats, Oils & Grease Waste and other liquid wastes
 - **Completed construction, Q3 2013**
 - New Hope Dairy Anaerobic Digester
 - Completed construction, Q3 2013
 - Warmerdam Dairy Anaerobic Digester
 - Completed construction, Q3 2013



New Hope Dairy Digester



1200 Milking Cows
New Hope (CRED) – developer owned;
450 kW (mostly peak and super peak); Q1
2013



June 2013

	kWh
Off-Peak	14,175.65
On-Peak	24,902.88
Super-Peak	37,033.15
Total Contracted kWh	76,111.68

July 2013

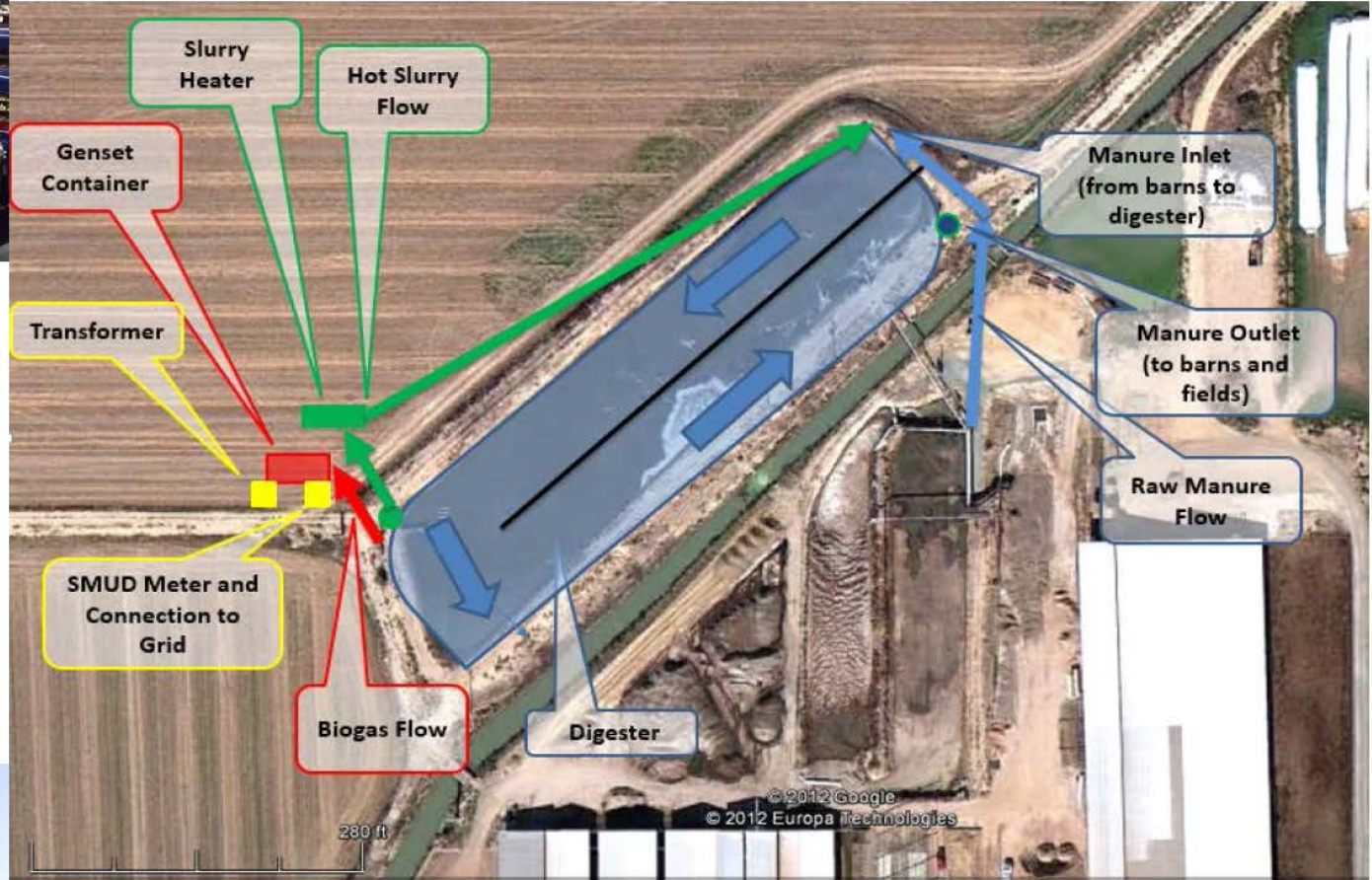
	kWh
Off-Peak	15,409.58
On-Peak	26,679.98
Super-Peak	43,395.17
Total Contracted kWh	85,484.74

Van Warmderdam Dairy Digester

Warmerdam (CRED) – developer owned; 600 kW (mostly peak and super peak); Starts Operation Q1 2013



Van Warmderdam Dairy Digester



Van Warmderdam Dairy Digester



Month	May 2013 (pre COD)	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
# Days	5	4	30	31	31	30	31	30	31	31	28
Off Peak kWh	1,840.85	233.23	8,370.67	1,345.78	75.31	5,754.82	-	0	-	66.19	0
Peak kWh	9,757.25	13,427.14	78,793.63	81,870.77	67,836.58	50,568.91	54,159.22	46,261.92	23,806.24	17,662.72	34,150.86
Super Peak kWh	6,569.52	6,013.98	78,534.00	82,232.77	76,798.51	74,036.74	84,277.82	67,840.46	77,407.19	71,882.35	76,870.47
Total kWh	18,168	19,674	165,698	165,449	144,710	130,360	138,437	114,102	101,213	89,611	111,021
Capacity Factor (%)	4%	4%	37%	37%	32%	29%	31%	26%	23%	20%	25%

Van Steyn Dairy Digester



Completed in Sep 2015
750 Milking Cows
225 kW

AD Food Wastes Digester at American River Packaging

Clean World Partners:

Demonstrate **10 ton per day facility** that utilizes corrugated waste to produce electricity with micro-turbines

Partners:

- American River Packaging
- Otto Construction
- Atlas Disposal
- UC Davis
- SMUD
- Campbell Soup Company
- California Energy Commission

130 kW output net metered
to SMUD grid



Sacramento Biorefinery #1

AD Food & Organic Wastes at SATS

Desired Outcome:

- Develop, demonstrate & deploy an AD technology 25 TPD of food wastes scalable to 100 TPD at Sacramento's South Area Transfer Station that will produce electricity, and renewable natural gas to power a fleet of 10 refuse trucks.
- Clean World also uses the digester effluent to produce and sell high value soil amendments.

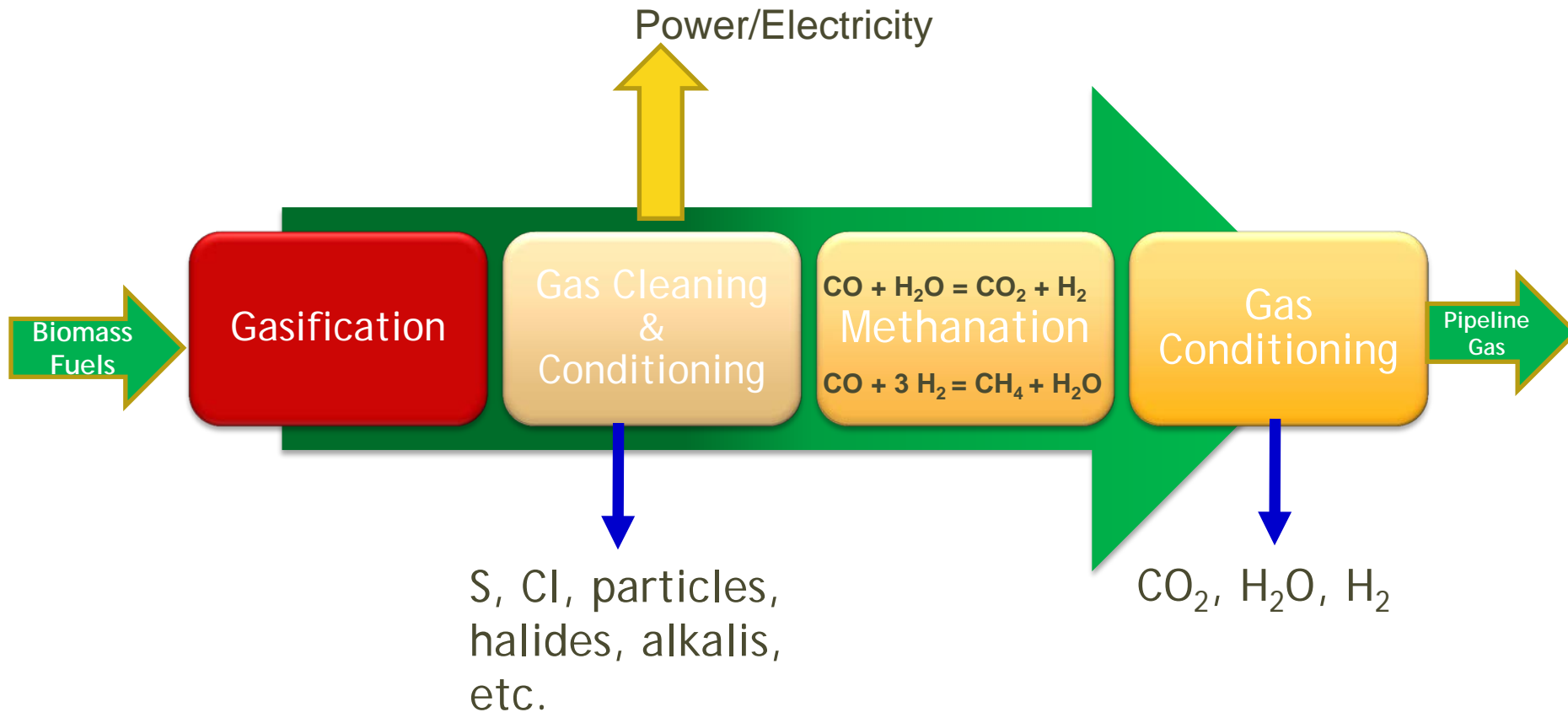
Partners:

- Clean World Partners
- SMUD
- Atlas Disposal
- CEC –AB 118 Program (\$6 Million Grant award)

190 kW net metered to SMUD grid



Biomass Gasification Process for DG & Pipeline Gas Quality Production



Partners: UC San Diego, West Biofuels, SMUD
Funded by CEC ~ \$1 Million
Objective: Lower the cost of methanation

Summary

- ◆ SMUD has aggressive Renewable Energy Supply & GHG Reduction goals
- ◆ Utilization of local biomass/waste, biogas & RNG provide benefits/challenges
- ◆ SMUD is committed to affordable, sustainable and environmentally beneficial energy solutions for our customer-owners

Thank You

Questions/Comments??

For more information please contact:

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