Opportunities and Challenges for Biogas & RNG Projects in SMUD Territory

Valentino Tiangco, Ph.D.

Renewable Waste Intelligence

2 Day Conference & Exhibition

Biogas West Coast 2016

October 10-11, 2016 • San Diego
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.
## Benefits - Why Biomass?

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Strategic Directives (SD) Being Addressed</th>
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<tbody>
<tr>
<td>Producing local renewable &amp; green energy for electricity production,</td>
<td>SD 1B, SD-7, SD-9, SD 10, SMUD 3.0 North</td>
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<tr>
<td>combined heat and power (CHP) and pipeline injection applications.</td>
<td>Star, DES, ER&amp;D Strategic Plan</td>
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<td>Reducing GHG emissions and destroying methane that otherwise would</td>
<td>SD-7, SD-9, SD 10, SMUD 3.0, North Star,</td>
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<td>be vented and contribute to global warming.</td>
<td>DES and ER&amp;D Strategic Plan</td>
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<td>Improving waste management (for manure wastes) for forest health,</td>
<td>SD-7, SD-9, SD 10, SMUD 3.0, North Star,</td>
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<td>timber stand improvement or implementation of best manure management</td>
<td>DES and ER&amp;D Strategic Plan</td>
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<td>practice.</td>
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<tr>
<td>Reducing odor and flies for livestock operation.</td>
<td>SD-7, SD-9, SD 10, SMUD 3.0, North Star,</td>
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<tr>
<td>DES and ER&amp;D Strategic Plan</td>
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<tr>
<td>Improving local air quality by reducing emissions of volatile organic</td>
<td>SD-7, SD-9, SD 10, SMUD 3.0, North Star,</td>
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<tr>
<td>compounds (VOCs).</td>
<td>DES and ER&amp;D Strategic Plan</td>
</tr>
<tr>
<td>Producing steady revenue source for the developer through electricity</td>
<td>SD-1B, SD-13, SMUD 3.0, North Star, DES</td>
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<td>sales lease agreements for farmers.</td>
<td>and ER&amp;D Strategic Plan</td>
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<tr>
<td>Co-producing heat and other value-added products for new agricultural</td>
<td>SD-7, SD-13, SMUD 3.0, North Star, DES</td>
</tr>
<tr>
<td>markets such as fertilizer or soil amendment – from biochar or digestate</td>
<td>and ER&amp;D Strategic Plan</td>
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<tr>
<td>Promote economic development by creating jobs and tax revenues.</td>
<td>SD-13, SMUD 3.0, North Star, DES and ER&amp;D</td>
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<tr>
<td>Economically revitalizing agriculture and rural communities.</td>
<td>Strategic Plan</td>
</tr>
<tr>
<td>Improving DG and local grid support.</td>
<td>D-9, SD 10, SMUD 3.0, North Star, DES and</td>
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<tr>
<td></td>
<td>ER&amp;D Strategic Plan</td>
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<tr>
<td>Reducing catastrophic wildfires for urban and forest interface,</td>
<td>SD 1B, SD-7, SD-10, SD 13, SMUD 3.0, North</td>
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<tr>
<td>improve forest health, watershed and timber stand, reduce costs of</td>
<td>Star, DES and ER&amp;D Strategic Plan</td>
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<td>forest management, reduce risks and improve public health and safety.</td>
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<td>Opportunities (Barriers/Challenges)</td>
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<tr>
<td><strong>Institutional (biggest reason)</strong></td>
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<tr>
<td>- State environmental policies and program are fragmented &amp; sometimes conflicting</td>
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<tr>
<td>- Arduous &amp; complex permitting process</td>
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<tr>
<td>- Limited public awareness of the benefits of biogas &amp; biomass gasification-methanation (RNG)</td>
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<tr>
<td><strong>Technical</strong></td>
<td></td>
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<tr>
<td>- NOx</td>
<td></td>
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<tr>
<td>- Biomass gasification-methanation remain to be fully demonstrated and commercialized</td>
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<tr>
<td>- New biomass developments viewed to have some technical risk</td>
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<tr>
<td>- Lack of commercial success and data for new &amp; emerging technologies</td>
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<tr>
<td>- Utility interconnection/transmission</td>
<td></td>
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<tr>
<td><strong>Economics</strong></td>
<td></td>
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<tr>
<td>- High costs</td>
<td></td>
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<tr>
<td>- Low prices of natural gas</td>
<td></td>
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<tr>
<td>- Financing is difficult</td>
<td></td>
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<tr>
<td><strong>Environmental</strong></td>
<td></td>
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<tr>
<td>- Environmental benefits are not internalized</td>
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<tr>
<td>- Catastrophic wildfire threat</td>
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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

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<tbody>
<tr>
<td>RPS</td>
<td>18.8%</td>
<td>20%</td>
<td>20.4%</td>
<td>33%</td>
</tr>
<tr>
<td>Greenergy</td>
<td>3.5%</td>
<td>3.8%</td>
<td>3.8%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>22.3%</td>
<td>23.8%</td>
<td>24.2%</td>
<td>37%</td>
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</table>
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 (NOx, 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
California Biomass Resources

Potential Feedstock Energy in Biomass
507 Trillion Btu/year

Agriculture, 137 TBTu, 24%
Forestry, 242 TBTu, 41%
Urban, 128 TBTu, 22%
Landfill Gas, 61 TBTu, 11%
Waste-water Treatment, 10 TBTu, 2%

Biomass (Million BDT/year)

Source: CBC 2009
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
- NOₓ
- 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

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<tr>
<th></th>
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<tbody>
<tr>
<td>Thermochemical</td>
<td>200</td>
<td>61</td>
<td>259</td>
<td>69</td>
</tr>
<tr>
<td>Biochemical</td>
<td>26</td>
<td>11</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>Total MW</td>
<td>226</td>
<td>72</td>
<td>287</td>
<td>81</td>
</tr>
</tbody>
</table>

Source: CBC 2008
**Biomass Potentials**

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

<table>
<thead>
<tr>
<th>Conversion Pathway</th>
<th>Technical Potential (MW)</th>
</tr>
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<tbody>
<tr>
<td>Thermochemical</td>
<td>898</td>
</tr>
<tr>
<td>Biochemical</td>
<td>96</td>
</tr>
<tr>
<td><strong>Total MW</strong></td>
<td><strong>994</strong></td>
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</tbody>
</table>

Source: CBC 2008
### Biogas Potentials in CA & Western US

(Resource Potentials for Pipeline Gas)

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<tr>
<th></th>
<th>California</th>
<th>Other 12 Western States</th>
<th>Total</th>
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<tbody>
<tr>
<td></td>
<td>Gross MW*</td>
<td>Gross MW*</td>
<td>Gross MW*</td>
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<tr>
<td>Wastewater Treatment Plants</td>
<td>210</td>
<td>351</td>
<td>561</td>
</tr>
<tr>
<td>Landfills</td>
<td>1300</td>
<td>990</td>
<td>2,290</td>
</tr>
<tr>
<td>Dairy Manure Digesters</td>
<td>470</td>
<td>566</td>
<td>1,036</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,980</strong></td>
<td><strong>1,907</strong></td>
<td><strong>3,887</strong></td>
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</tbody>
</table>

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


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

- Wind, 774, 28.48%
- Solar, 283, 10.41%
- Geothermal, 147, 5.41%
- Eligible Hydro < 30MW, 193, 7.10%
- Biomethane, 556, 20.45%
- Dairy Biogas, 6, 0.21%
- Combustion, 549, 20.19%
- Landfill Gas to Energy, 136, 5.01%
- Digester Gas, 74, 2.74%
- Other, 1321, 49%
Biomass Projects
Biomass-Derived Methane Gas

Landfill Gas From Landfills

Digester Gas From AD of Food Wastes

Biogas From AD Livestock operations

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.
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
  - New Hope Dairy Anaerobic Digester
    - Under construction
  - Warmerdam Dairy Anaerobic Digester
    - Beginning construction
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

<table>
<thead>
<tr>
<th></th>
<th>kWh</th>
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<tbody>
<tr>
<td>Off-Peak</td>
<td>14,175.65</td>
</tr>
<tr>
<td>On-Peak</td>
<td>24,902.88</td>
</tr>
<tr>
<td>Super-Peak</td>
<td>37,033.15</td>
</tr>
<tr>
<td>Total</td>
<td>76,111.68</td>
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### July 2013

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<tr>
<th></th>
<th>kWh</th>
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<tbody>
<tr>
<td>Off-Peak</td>
<td>15,409.58</td>
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<tr>
<td>On-Peak</td>
<td>26,679.98</td>
</tr>
<tr>
<td>Super-Peak</td>
<td>43,395.17</td>
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<tr>
<td>Total</td>
<td>85,484.74</td>
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Van Warmderdam Dairy Digester

Warmerdam (CRED) – developer owned; 600 kW (mostly peak and super peak); Starts Operation Q1 2013
## Van Warmderdam Dairy Digester

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<tbody>
<tr>
<td># Days</td>
<td>5</td>
<td>4</td>
<td>30</td>
<td>31</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>31</td>
<td>28</td>
</tr>
<tr>
<td>Off Peak kWh</td>
<td>1,840.85</td>
<td>233.23</td>
<td>8,370.67</td>
<td>1,345.78</td>
<td>75.31</td>
<td>5,754.82</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>66.19</td>
<td>0</td>
</tr>
<tr>
<td>Peak kWh</td>
<td>9,757.25</td>
<td>13,427.14</td>
<td>78,793.63</td>
<td>81,870.77</td>
<td>67,836.58</td>
<td>50,568.91</td>
<td>54,159.22</td>
<td>46261.92</td>
<td>23,806.24</td>
<td>17,662.72</td>
<td>34150.86</td>
</tr>
<tr>
<td>Super Peak kWh</td>
<td>6,569.52</td>
<td>6,013.98</td>
<td>78,534.00</td>
<td>82,232.77</td>
<td>76,798.51</td>
<td>74,036.74</td>
<td>84,277.82</td>
<td>67,840.46</td>
<td>77,407.19</td>
<td>71,882.35</td>
<td>76870.47</td>
</tr>
<tr>
<td>Total kWh</td>
<td>18,168</td>
<td>19,674</td>
<td>165,698</td>
<td>165,449</td>
<td>144,710</td>
<td>130,360</td>
<td>138,437</td>
<td>114,102</td>
<td>101,213</td>
<td>89,611</td>
<td>111,021</td>
</tr>
<tr>
<td>Capacity Factor (%)</td>
<td>4%</td>
<td>4%</td>
<td>37%</td>
<td>37%</td>
<td>32%</td>
<td>29%</td>
<td>31%</td>
<td>26%</td>
<td>23%</td>
<td>20%</td>
<td>25%</td>
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</tbody>
</table>
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

- **Gasification**
- **Gas Cleaning & Conditioning**
- **Methanation** (CO + H₂O = CO₂ + H₂, CO + 3 H₂ = CH₄ + H₂O)
- **Gas Conditioning**

- Power/Electricity

- Biomass Fuels → Gasification → Gas Cleaning & Conditioning → Methanation → Gas Conditioning → Pipeline Gas

- S, Cl, particles, halides, alkalis, etc.

- 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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(916)732-6795