Wheeling Power to Meet the California RPS

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Overview:

- SMUD
- Drivers & Renewable Energy Goals
- SMUD’s Renewable Energy Mix
- Some Renewable Energy Projects
- Summary
- Publicly Owned (Sixth Largest in U.S.)
- Service area of 900 square miles, serving 1.4 Million (Sacramento County and parts of Placer)
- Over 595,000 Residential, Commercial and Industrial customers
- Record peak demand-3,299 MW on July 24, 2006
- 1st in customer satisfaction survey for the last 9 consecutive years (J.D. Power & Associates Survey)
What Is Driving SMUD’s Renewable Energy Development?

- **GHG regulations**
  - Reshaping energy supply
  - Prompting RE developments
  - Climate change

- **RPS-driven energy additions**
  - Pipeline injection
  - Utilizes existing transmission pipeline infrastructure
  - Local RE development

- **Other Environmental Concerns**
  - Local and problem wastes
  - Health and Safety Issues
  - Reduce Emissions (NOx, H$_2$S, etc)

- **Loss of Energy Resources**
  - Electricity and heat
  - Transportation fuels
  - Additional revenue stream for agricultural and other sectors
  - Productive use of organic waste materials

- **Board’s Strategic Directives & Policy - Sustainable Power Supply**
Sustainable Power Supply Objective

A 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 (i.e. <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

- 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
Other Challenges

- Resource Availability/Sustainability
- Arduous Permitting Process
- Financing and Availability of Equity/Cost Allocation/Cost Recovery
- Constrained and Insufficient Transmission and Distribution (T&D) Infrastructure
- High Upfront Capital Costs
## Renewable Energy Supply Goals

<table>
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<tr>
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<tbody>
<tr>
<td>RPS</td>
<td>17.5%</td>
<td>18.8%</td>
<td>20%</td>
<td>33%</td>
</tr>
<tr>
<td>Greenergy</td>
<td>3.5%</td>
<td>3.5%</td>
<td>3.9%</td>
<td>4%</td>
</tr>
<tr>
<td>Totals</td>
<td>21%</td>
<td>22.3%</td>
<td>23.9%</td>
<td>37%</td>
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</table>
Renewable Energy Supply vs. Goals

[Graph showing renewable energy supply compared to goals from 2007 to 2030, indicating the shortfall in energy deficit and the application of surplus to meet goals, with a forecast for a 37% renewables goal by 2020 (Potential EE - Baseline Forecast).]
SMUD's RENEWABLE ENERGY MIX

2009 Renewable Energy Mix

- **Biomass**: 1096; 49%
- **Wind**: 560; 25%
- **Small Hydro**: 367; 16%
- **Geothermal**: 217; 10%
- **PV**: 5; 0%
SMUD's RENEWABLE ENERGY MIX

2010 (2,600 GWh estimated)

Wind, 719 GWh, 27%
PV, 4 GWh, 0%
Small Hydro, 301 GWh, 12%
Geothermal, 0 GWh, 0%
Biomass, 1603 GWh, 61%
Biomass, 1356 GWh, 52%
Biomethane*, 247 GWh, 9%
(Pipeline gas to CPP)
SMUD Projected Resource Mix Through 2050

- 2020 EE/DSM @ 2.5X 2007
- Unknown Generation
- 33% RPS @ 2020 Requirements
- Hydro (UARP + WAPA)
- Natural Gas Resource
- SMUD Gas Fired Generation

Total Retail Demand

Energy Gap

Total Projected Energy Demand and Resource Supply GWH

- 2008
- 2010
- 2012
- 2014
- 2016
- 2018
- 2020
- 2022
- 2024
- 2026
- 2028
- 2030
- 2032
- 2034
- 2036
- 2038
- 2040
- 2042
- 2044
- 2046
- 2048
- 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)
1. SMUD Owned & Operated – Large
   • Innovative Ownership Options
2. Private (IPP) Owned - Renewables
   Bidding w/ Cost & Value Ranking
   • RFO
   • Unsolicited Proposals
3. Private (Customer) Owned - Net
   Metering (i.e., Retail Rates for Gen)
4. Private (IPP) Owned - Feed-In Tariff
   (FIT) began 1/1/2010
   • Value-Based, No Negotiation
     Contract (PPA)
5. RD&D Innovations
Renewable Energy Development
Biomass
Biomass Energy Conversion Pathways

**BioPower:**
- Electricity
- Heat
- CHP & CCHP

**Pipeline Gas**

**Biofuels:**
- Ethanol
- Biodiesel
- Methanol
- Hydrogen
- SNG
- Pyrolysis Oil
- Others

**Bioproducts & Chemicals**

**Utilization**
Biomass-Derived Methane Gas

Landfill Gas From Landfills

Digester Gas From AD of Wastewater Treatment Plants

Biogas From AD of Livestock operations

Digester Gas From AD of Food Wastes

Producer Gas or Syngas From Gasification of Biomass?
# Biogas Opportunities in the Western US

**(Resource Potentials for Pipeline Gas)**

<table>
<thead>
<tr>
<th></th>
<th>California</th>
<th>Other 12 Western States</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gross MW*</td>
<td>Gross MW*</td>
<td>Gross MW*</td>
</tr>
<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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</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-digestions or stand-alone AD)
Biomass is making a significant contribution to RPS & Greenergy Goals
Existing Biomass Projects – PPA’s

- Carson PP (WWTP) - Digester Gas (adjusted for ~90% nat. gas portion), Sacramento, CA
- Kiefer I & II – LES, Sacramento, CA
- Yolo Landfill, Davis, CA
- Avista (75 MW @ ~ 24x7) - WA
- SPI / SCL - Burlington (15 MW @ 90% CF = 118 GWh) - WA
- Simpson (43 MW; 339 GWh; Tacoma, WA)
- GRS - Santa Cruz Landfill, CA (1.5 MW; 12 GWh/yr) –
- Shell Biomethane / Consumnes PP (CPP) (200 to 300 GWh/yr) to CPP-Texas
- Snohomish (at full dispatch) (adjusted for 12.5% nat. gas portion) – WA – 38.5 MW ---contract expired
Biogas for Pipeline Injection

Current Contracts:
1. **Landfill Gas –Texas** (4,500 to 6,000 MMBTu/day)
2. **Biogas from AD of Dairy Wastes/Co-digestion- Colorado** (3,000-7,000 MMBtu/day)
3. **Another Landfill gas -SMUD’s Board Approved in November 2010**

Deployment Projects (Co-Funded by USDOE & CEC):
1. **Co-digestion of Food Wastes at Sacramento Wastewater Treatment Plant**
2. **AD of food wastes and other organic wastes at Sacramento Recycling & Transfer Station**
Common Carrier of Gas Pipelines in CA
SMUD’s Biopower Today

<table>
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<tr>
<th>Technology/Fuel Source</th>
<th>Number of facilities*</th>
<th>GWh</th>
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<tbody>
<tr>
<td>Solid Fuel Combustion</td>
<td>4</td>
<td>1,156</td>
</tr>
<tr>
<td>Biogas - Landfill gas-to-energy</td>
<td>3</td>
<td>389</td>
</tr>
<tr>
<td>Biogas - Wastewater treatment</td>
<td>1</td>
<td>56</td>
</tr>
<tr>
<td>Biogas - Dairy digester</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Totals</td>
<td>10</td>
<td>1603</td>
</tr>
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</table>

* In and outside of SMUD Region
SMUD Community Renewable Energy Development Project

- USDOE ARRA Grant Award ($5,000,000)
- CEC PIER Grant Award ($500,000)
- 5 projects
  - Sacramento Solar Highways
  - County Wastewater Treatment Plant - Co-Digestion of Fats, Oils & Grease Waste and other liquid wastes
  - New Hope Dairy Anaerobic Digester
  - Warmerdam Dairy Anaerobic Digester
  - Food Wastes Anaerobic Digester
SMUD CRED
Community Renewable Energy Deployment Projects

- Food Wastes AD at BLT
- Solar
- New Hope Dairy AD
- SMUD Community
- SRCSD Co-Digestion of FOG
- Warmerdam Dairy AD
Sacramento Solar Highways

- Project in planning stages
- Two phases of feasibility study complete
- Environmental study is underway

- Large number of technical and safety criteria
- Initial site survey resulted in “Midtown” Sacramento and Rancho Cordova site selection
Sacramento Solar Highways Technology

“Traditional” flat-plate photovoltaic modules

Advanced, concentrator photovoltaic panels with dual-axis tracking
From South-end 48th D.C. (east side), view to ~East, of freeway, PV location is north slope (left)

From T St., ~60th St. at fence; view ~North, of north side freeway, east of overcrossing, proposed PV location.
Co-Digestion of FOG & other Liquid Wastes at Sacramento Regional County Sanitation District

- Successful Pilot Tests
- Next Step – Commercial Demo -$1.5M award as part of SMUD-CRED
  - Validate feedstock availability assumptions
    - Updated food processing waste survey December 2009
    - SRCSD in discussions with specific generators
  - Continue seeking additional funding
  - Finalize Business Case and seek approval for permanent, full-scale facility
    - SMUD planning a pipeline injection to make more efficient use of the renewable biogas
Co-Digestion of FOG & other Liquid Wastes at Sacramento Regional County Sanitation District

FOG & Other Liquid Wastes

Digester

Biogas Clean-Up

Pipeline quality gas

Wastewater

SMUD’s COSUMNES POWER PLANT
BLT-AD Project

Desired Outcome:
- Install above ground and complete mix digester that will utilize food processing wastes and other organic wastes
- Biogas will be used for pipeline injection

Partners:
- Sacramento Recycling & Transfer Station, Real Energy, NatureWise Technology, Clean World Partners
BLT-AD Project

Food wastes & other organic wastes

Pipeline quality gas

SMUD’s COSUMNES POWER PLANT
New Dairy Digesters in Development

Objective: Demonstrate and deploy new and advanced digesters that will employ above ground & complete mix digesters and low NOx engines at New Hope Dairy and Warmerdam Dairy both for CHP applications.

<table>
<thead>
<tr>
<th></th>
<th>New Hope Dairy</th>
<th>Warmerdam Dairy</th>
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<tbody>
<tr>
<td>Milking Cows</td>
<td>1,050</td>
<td>1,100</td>
</tr>
<tr>
<td>Engine Size</td>
<td>500 kW</td>
<td>800 kW</td>
</tr>
<tr>
<td>Type of Prime Mover</td>
<td>Low NOx Greenguard™ Engine</td>
<td>Guascor + SCR</td>
</tr>
<tr>
<td>Expected Start of Operation</td>
<td>Q4 2011</td>
<td>Q4 2011</td>
</tr>
<tr>
<td>Digester Type</td>
<td>Complete Mix (above ground)</td>
<td>Complete Mix (above ground)</td>
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New Hope Dairy Farm AD Project

WEA, CalBio

Site Features

Free Stalls

Water Beds

Flush Lane with rubber mat
SMUD’s Solano Wind Project
Phase 1 Project (1999-2004)

- Vestas V47 (660 kW)
- Single WTG installed in 1999 for evaluation
- 15 WTGs added in 2003 at 50-meter hub height
- 7 WTGs installed in 2004 at 65-meter hub height
- Total Phase 1 capacity: 15 MW
- 21kV overhead collection system – 3.2 miles
- 230kV interconnection
Phase 2 Project (2005-2007)

- Vestas V90 (3 MW)
- Phase 2A: 8 WTGs installed in May 2006 (24 MW total)
- Phase 2B: 21 WTGs installed in December 2007 (63 MW total)
- Total Phase 2 capacity: 87 MW
Solano Wind Phase 1 & 2
Phase 3 Project
Phase 3 Project

- EIR adopted
- Contracts awarded to Vestas (EPC and O&M)
- 24 V90-3.0MW and 31 V90-1.8MW turbines (55 total = 128 MW)
- Construction schedule:
  - Break ground June 2011
  - Commercial online date February 2012
- Interconnection agreement in place
- Additional collection system and generation step-up transformer capacity required
- Includes expansion of existing O&M building
Each powerhouse serves as a step on the UARP power stairway as the water drops one mile in elevation over a 53-mile course, beginning at Rubicon Reservoir (6,545 feet elevation) and ending at White Rock Powerhouse (993 feet elevation).
SMUD’S PV Portfolio

- Consistent Leadership for over 25 years
- Utility designed, owned & operated to incentives
- Currently approximately 20 MW$_{AC}$
- Over 1000 installations
- Residential, Commercial and Utility Scale
SolarSmart\textsuperscript{SM} Homes

- Partnership with homebuilders to build SolarSmart new homes
- Builders get incentive
- Homes include
  - PV systems
  - Energy efficient features

Premier Gardens, Rancho Cordova, CA
SMUD’s Pumped Hydro Project

Key Features of Iowa Hill

- New development added to existing hydro system
- 400-MW Pumped-storage facility
- New 6,400 ac-ft reservoir atop Iowa Hill
- Existing Slab Creek Reservoir as lower reservoir
- Underground water conveyance and powerhouse
- 2.5-mile transmission tie-in connects to existing UARP transmission line

Benefits

- Helps meet load growth
- Enables firming capacity of intermittent, non-dispatchable renewables
- Supports load following, improves system reliability, provides voltage control and spinning reserves
Summary

> SMUD is on track to become the first California utility to receive 20 percent of its energy from renewable resources

> SMUD is demonstrating that it’s possible to deliver non-polluting, renewable energy at an affordable rate without compromising reliability
Summary

> GHG/RPS goals/regulation driving SMUD to more renewables and other low carbon solutions

> SMUD is planning for sustainable energy supplies by 2050

> Transmission constraints driving SMUD to local solutions

> Local renewables for SMUD means biomass and solar

> Continue RD&D innovations and better define strategic values
Thank You

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