Wheeling Power to Meet the California RPS

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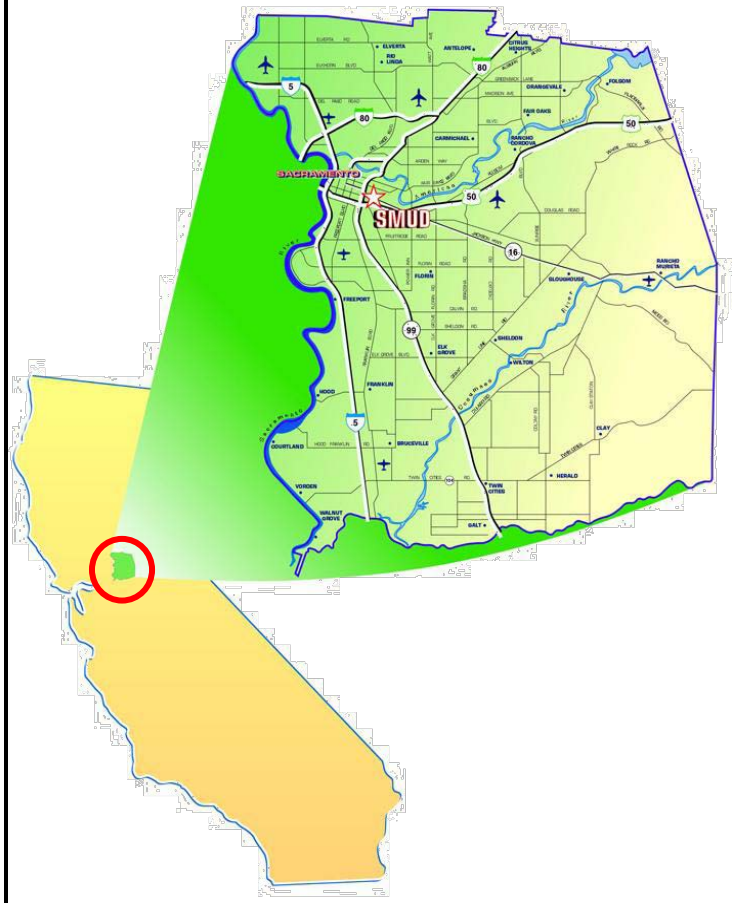
www.smud.org

Overview:

- SMUD
- Drivers & Renewable Energy Goals
- SMUD's Renewable Energy Mix
- Some Renewable Energy Projects
- Summary

SMUD



- **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)**

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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_2S, 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

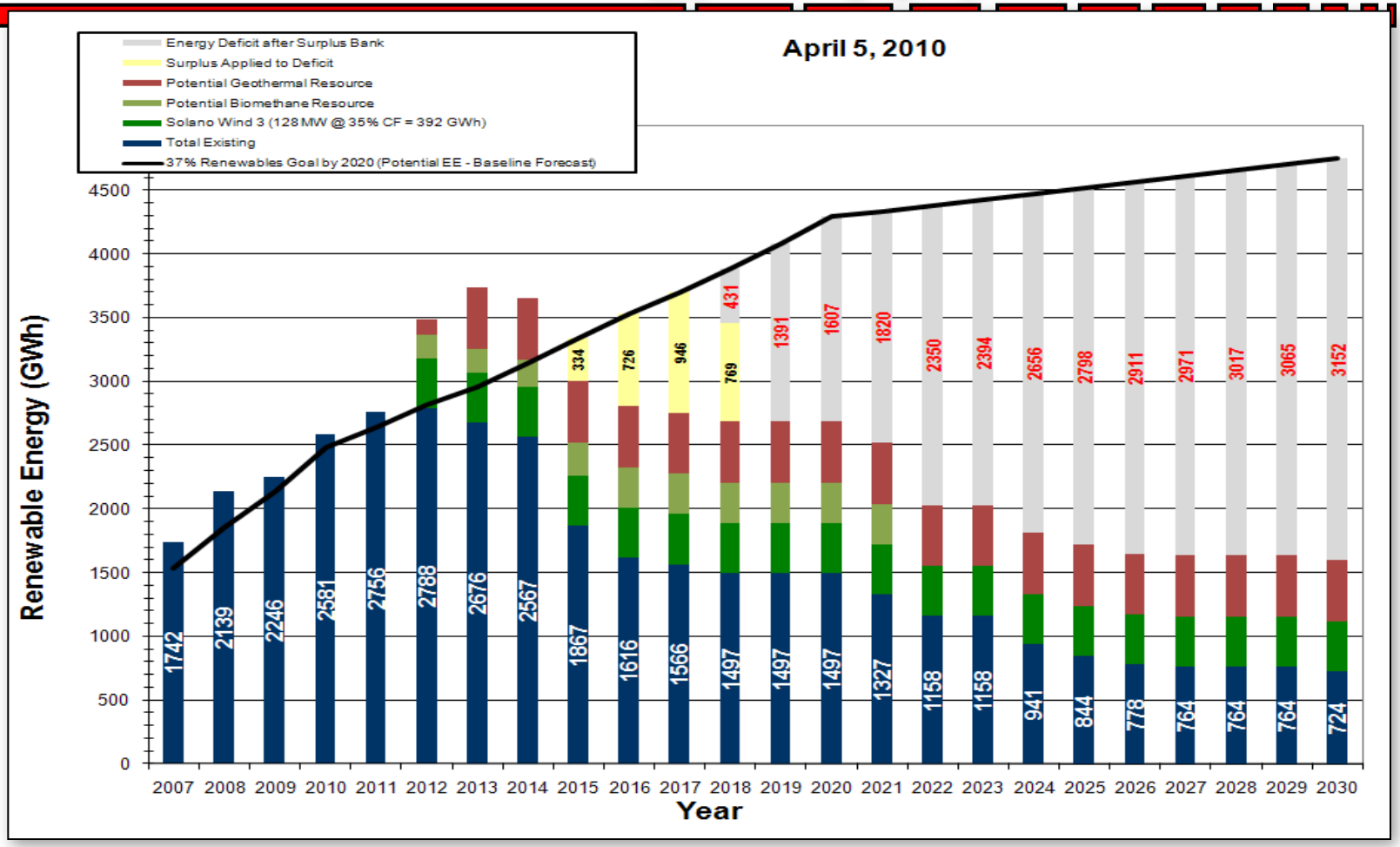
Other Challenges

- 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

SMUD Renewable Energy Program	2009 Supply Goal	2009 Actual	2010 Goal	2020 Goal
RPS	17.5%	18.8%	20%	33%
Greenergy	3.5%	3.5%	3.9%	4%
Totals	21%	22.3%	23.9%	37%

Renewable Energy Supply vs. Goals



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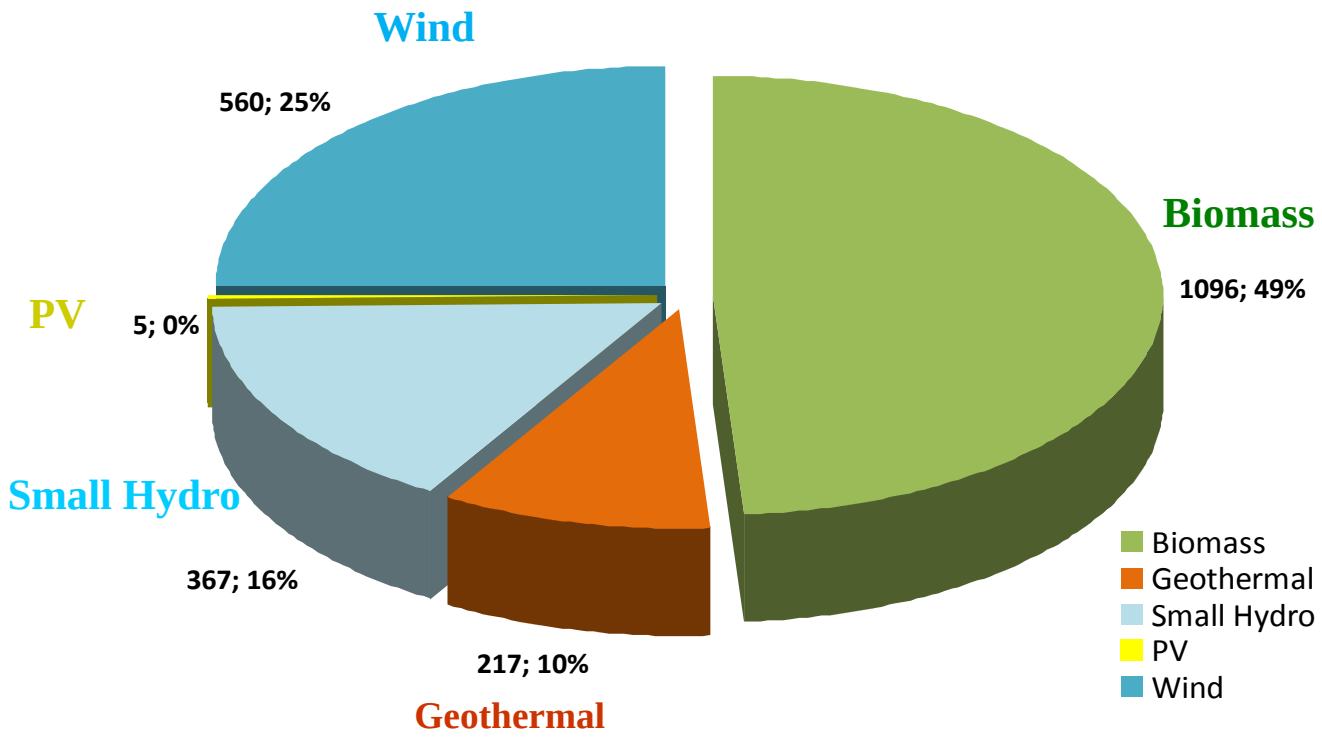
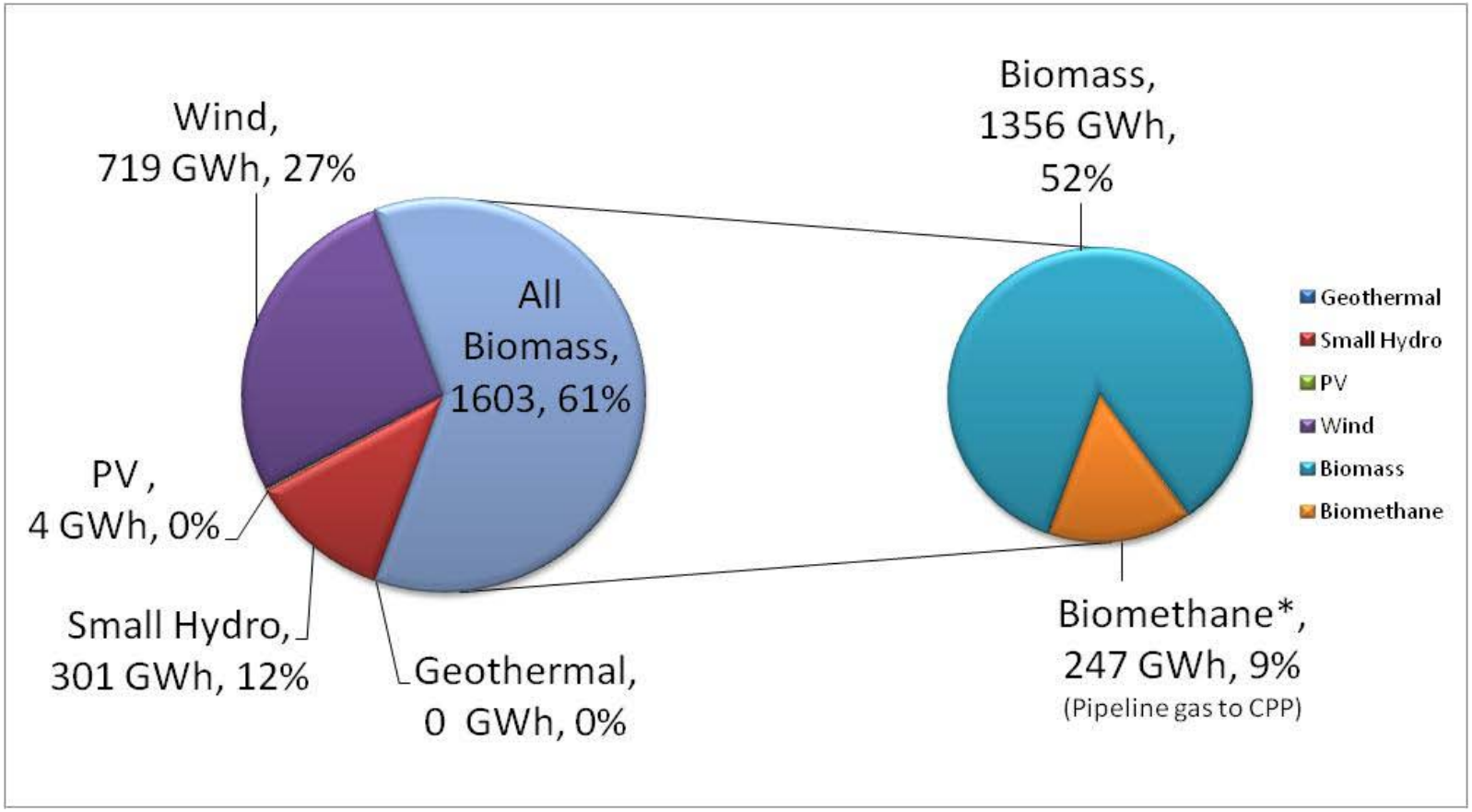
SMUD's RENEWABLE ENERGY MIX

2009 Renewable Energy Mix

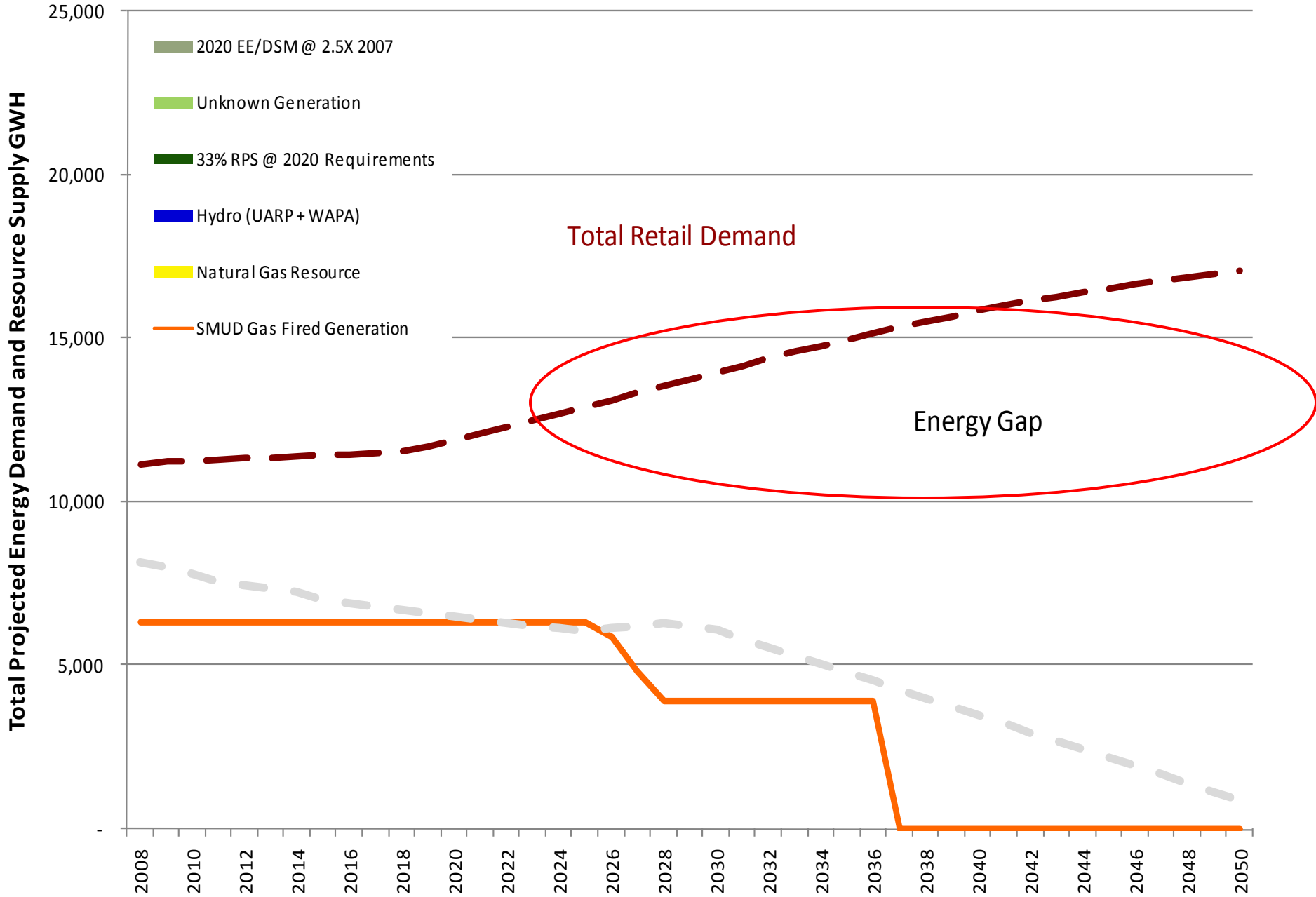


SMUD's RENEWABLE ENERGY MIX

2010 (2,600 GWh estimated)



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)**

APPROACHES IN BUILDING RENEWABLES

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

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, H_2S
NOx
CO_2

Utilization

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

Pipeline Gas

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

Bioproducts & Chemicals

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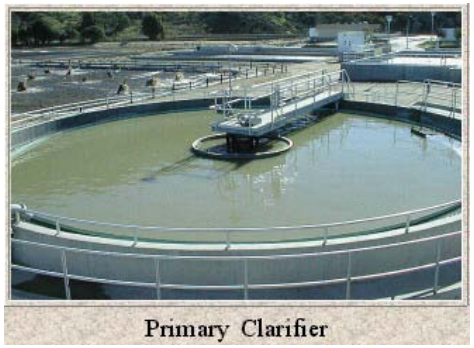
Biomass-Derived Methane Gas

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 ?

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Biogas Opportunities in the 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

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

Biomass is making a significant contribution to RPS & Greenergy Goals

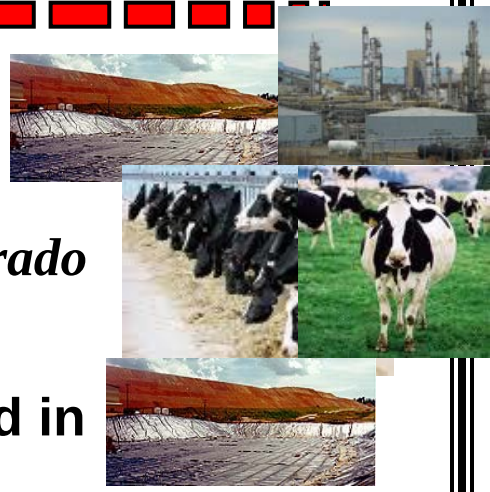
Existing Biomass Projects – PPA's

- Existing RPS & Greenergy Biomass Projects
  - 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**

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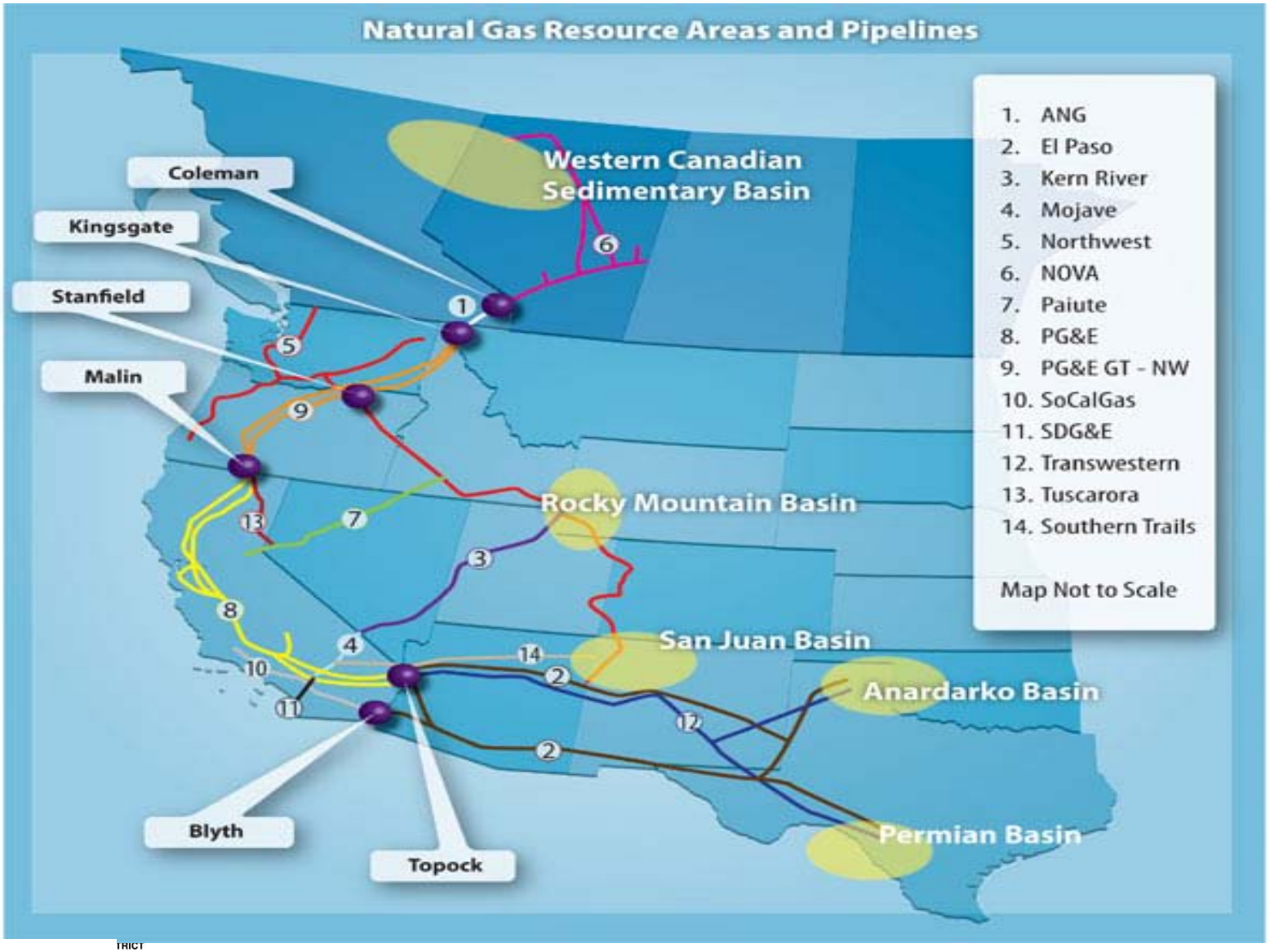
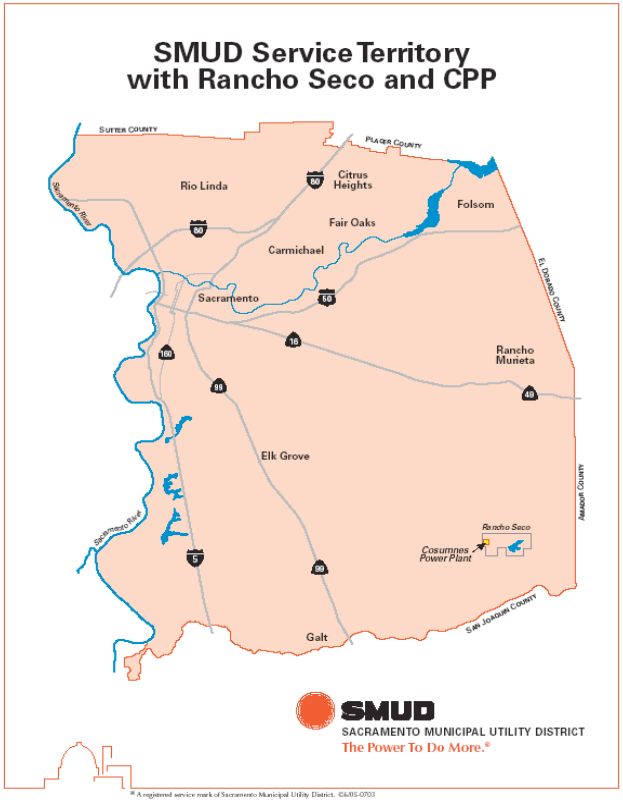
Common Carrier of Gas Pipelines in CA



SMUD's Biopower Today



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

* In and outside of SMUD Region

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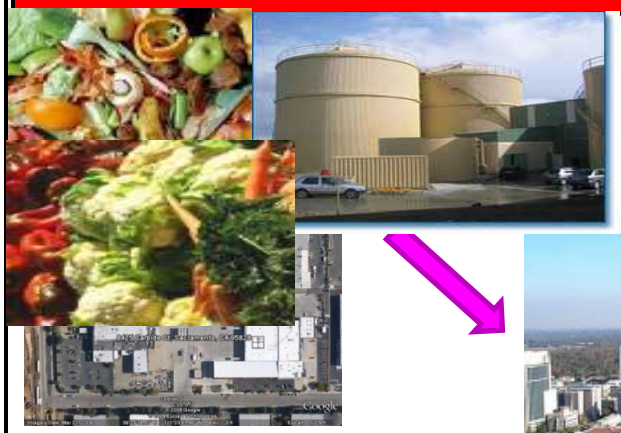
SMUD Community Renewable Energy Development Project

- 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

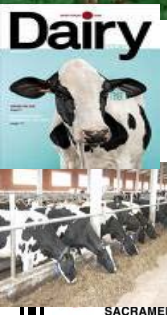
Community Renewable Energy Deployment Projects

Food Wastes AD at BLT



Solar

New Hope Dairy AD



Warmerdam Dairy AD

SRCSD Co-Digestion of FOG

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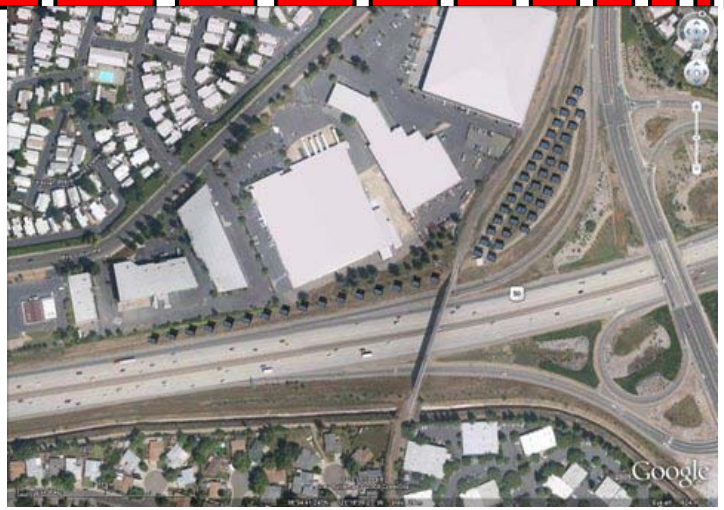
Sacramento Solar Highways

- 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"~~ East Sacramento Sacramento and Rancho Cordova site selection**

Sacramento Solar Highways Technology

"**T**raditional" flat-plate photovoltaic modules

Advanced, concentrator photovoltaic panels with dual-axis tracking

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From South end 48th O.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

Biogas Clean-Up

Pipeline quality gas

Wastewater

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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

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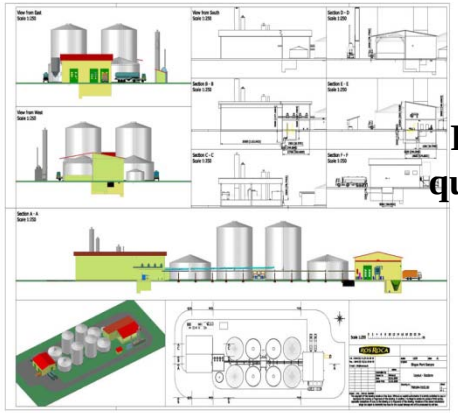
BLT-AD Project

Food wastes & other organic wastes



Pipeline quality gas

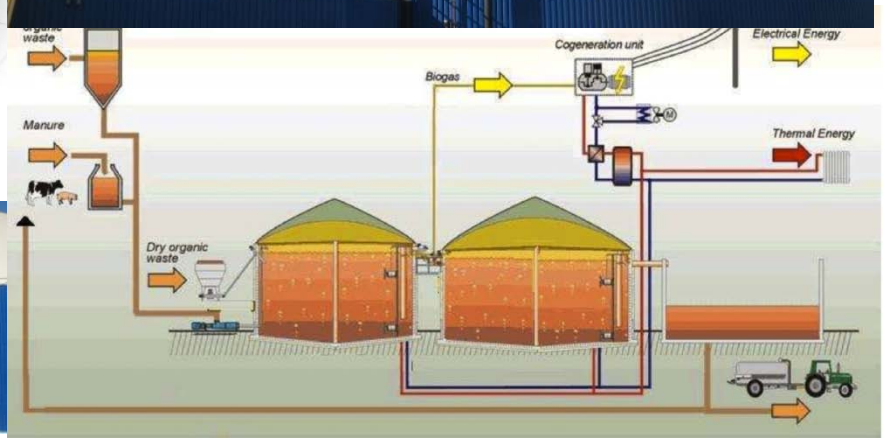
New Dairy Digesters in Development

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.

	New Hope Dairy	Warmerdam Dairy
Milking Cows	1,050	1,100
Engine Size	500 kW	800 kW
Type of Prime Mover	Low NOx Greenguard™ Engine	Guascor + SCR
Expected Start of Operation	Q4 2011	Q4 2011
Digester Type	Complete Mix (above ground)	Complete Mix (above ground)
Partners	USDOE, CEC, SMUD, Williams Engineering, CalBio, New Hope Dairy	USDOE, CEC, SMUD, Innate Energy, Warmerdam Dairy

Warmerdam Farm AD & GenSet

Innate Energy
California, LLC



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New Hope Dairy Farm AD Project

WEA

WEA, CalBio

MT-ENERGIE USA
Biogas Technology

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SMUD's Solano Wind Project

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Phase 1 Project (1999-2004)

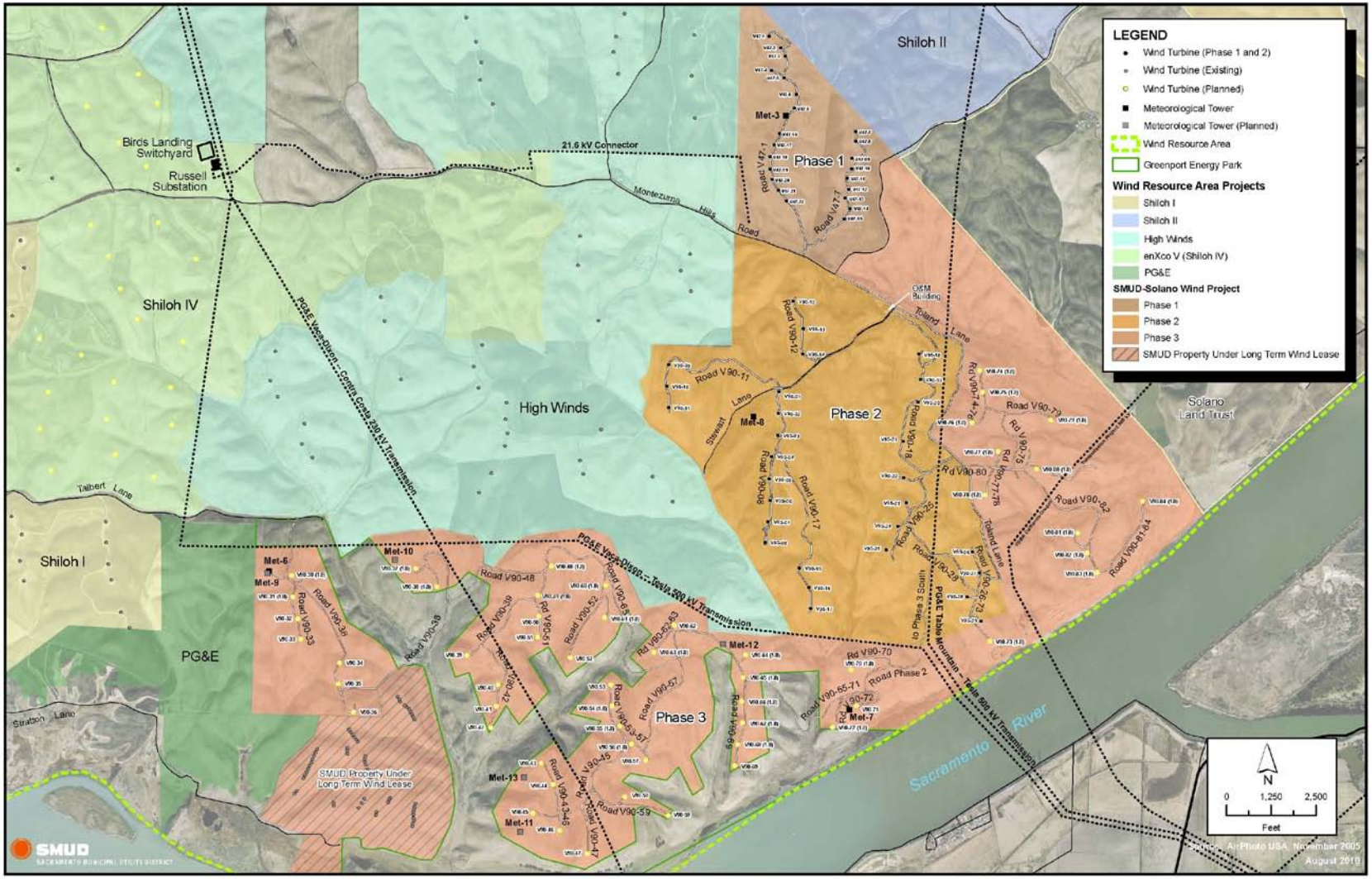
- Vestas V47 (660 kW)
- Single WTG installed in 1999 for evaluation
- 15 WTGs added in 2003 at 50-meter hub height
- 7 WTGs installed in 2004 at 65-meter hub height
- Total Phase 1 capacity: 15 MW
- 21kV overhead collection system – 3.2 miles
- 230kV interconnection

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



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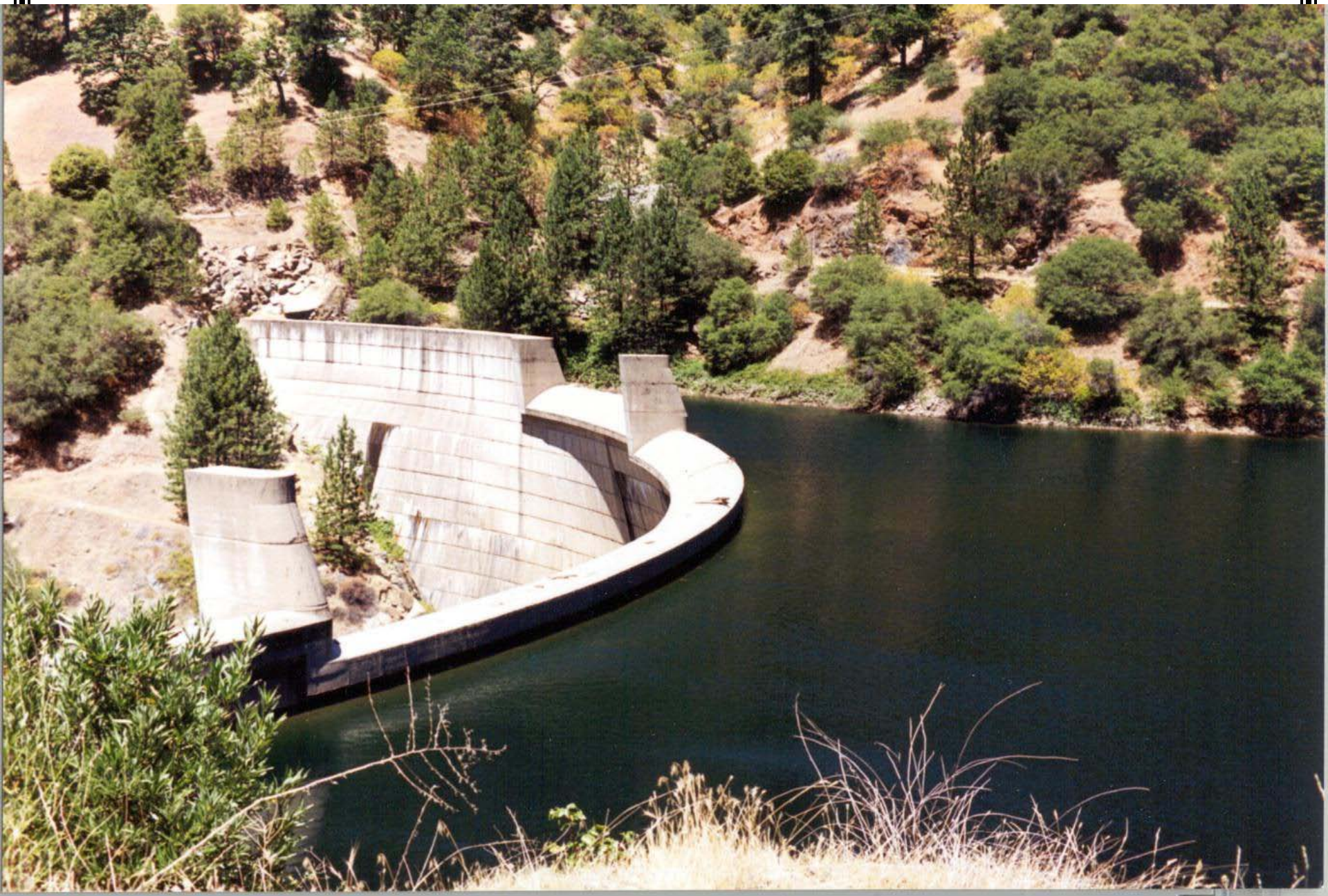
Phase 3 Project

- 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

HYDRO



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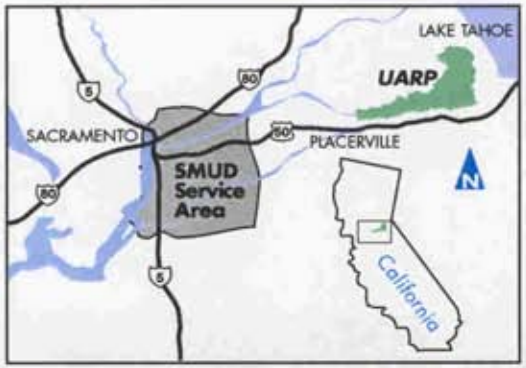
Upper American River Project

Federal Energy Regulatory Commission Project No. 2101



UARP Profile
Not to Scale

Notes:
1. elevation (el.) denotes full pool elevation
2. acre feet (af) denotes full pool storage

UARP Plan
Scale in Miles: 0 1 2 3 4 5

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).

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1066-00 10/31/00

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

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SolarSmart^{SM} Homes

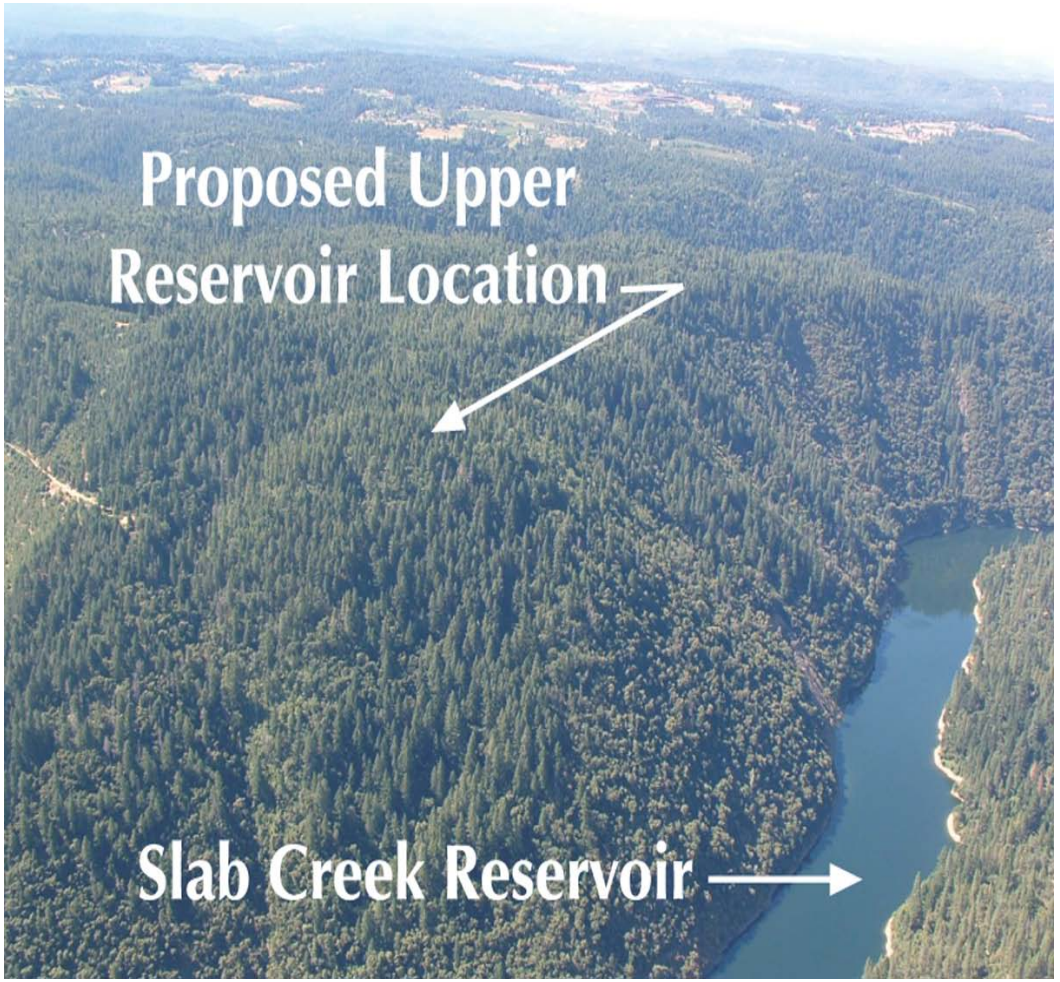
Premier Gardens, Rancho Cordova, CA
http://www.bira.ws/projects/premier-gardens.php

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

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 its 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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