A Utility Perspective on Anaerobic Digestion

Biocycle
Anaerobic Digestion of MSW Workshop
April 12, 2010

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SUMMARY

- SMUD Background
  - Sustainable Power Supply / RPS Goals
- The Smart Grid & Distributed Generation
- SMUD's Local Biomass Program & AD Projects
- Newest Incentive: Feed-In Tariff
- Barriers & Solutions

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The Conundrum of Abundance

Things Being What They Are. Chester Arnold.
Center for Contemporary Art, Sacramento
Image courtesy of the artist and Catharine Clark Gallery, San Francisco.

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About SMUD

- Publicly owned, non-profit electric utility serving Sacramento County for 60+ years
  - 5th largest electric utility in CA
  - 6th largest municipal utility in US, 2nd in CA
- Overseen by an elected board of directors
- Service Area
  - 900 square mile service area covering Sacramento County and a portion of Placer County
  - 590,000 customers within a 1.4 million service area population
  - 477 miles of Transmission lines, 9,736 miles of Distribution lines
- Other Facts
  - 2,100 employees
  - Operate Balancing Authority in Northern California
  - Operated Rancho Seco Nuclear power plant until shuttered by voter referendum in 1989
  - S&P Bond rating increased from A to A+ rating in April 2009
    - One reason cited was that SMUD is "ahead of most utilities in addressing climate change"

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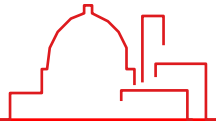
Sustainable Power Supply Objective

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.



SMUD Renewable Energy Goals

- Renewables Portfolio Standard (RPS), and Green Pricing Program ('Greenergy')

Renewable Energy Program	2009 Supply Goal	2009 Actual	2010 Goal	2020 Goal
RPS	17%	17.3%	20%	33%
Greenergy	3%	3.5%	3%	4%
Totals	20%	20.8%	23%	37%

- Biomass represents 49% of SMUD's 2009 RPS, projected to be 61% in 2010

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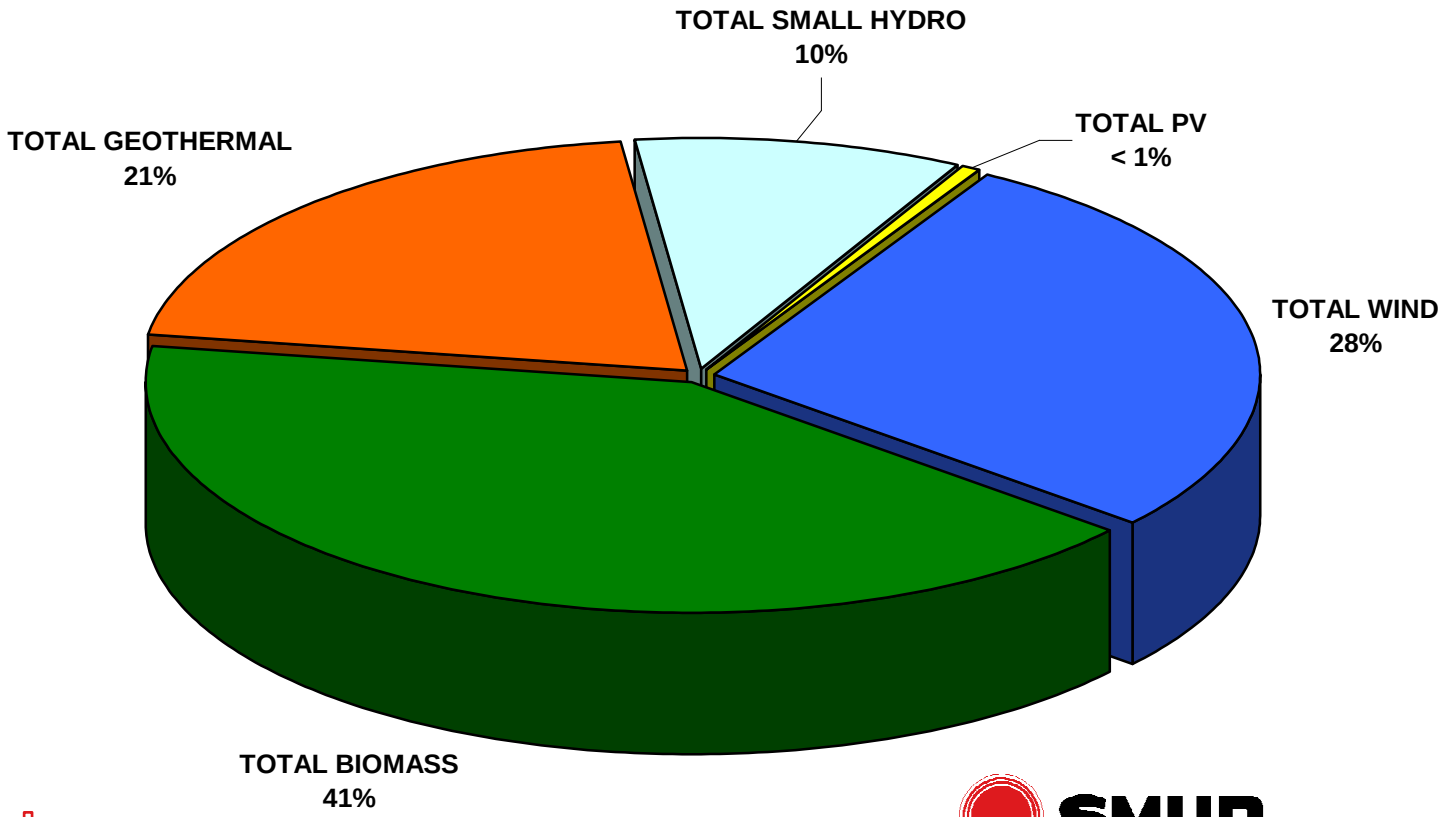
SMUD's 2008 Renewable Energy Mix

(RPS and Greenergy)



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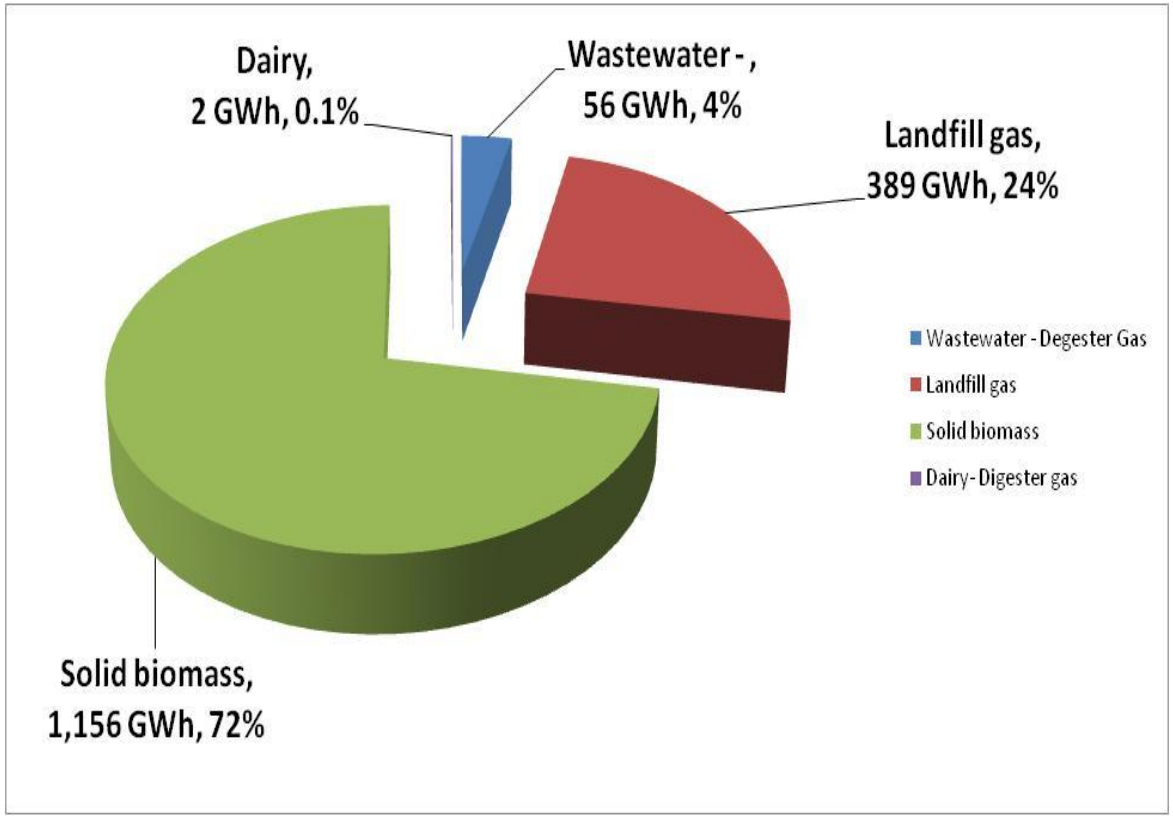
2010 Biomass Renewables Mix (Projected)

Biopower Provides
~1,600 GWh of Electricity through

- Direct Combustion of solid biomass
- Landfill Gas to Energy (LFGTE)
- Wastewater to Digester Gas
- Dairy Biogas Systems



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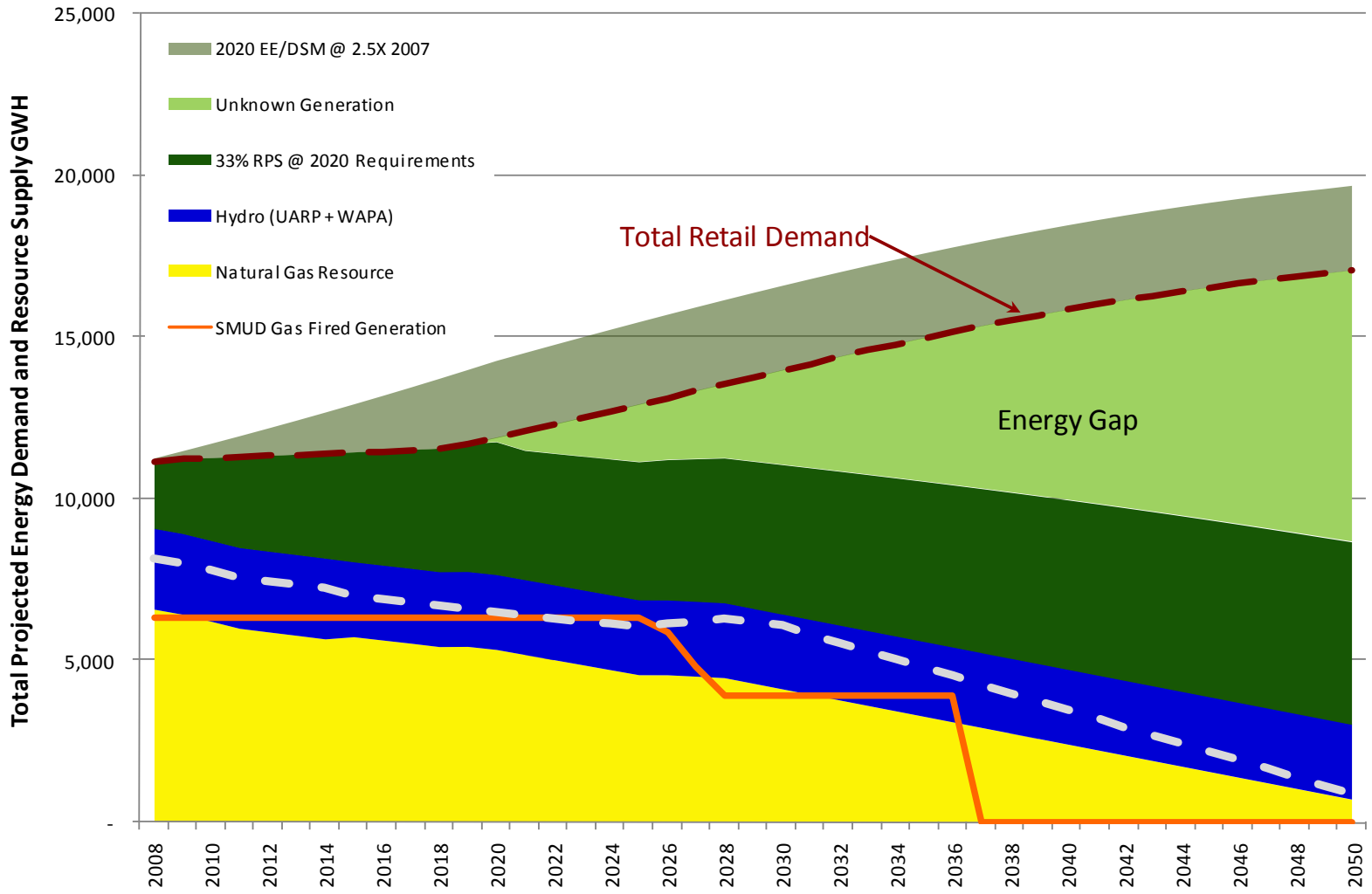
SMUD Projected Resource Mix Through 2050



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SMUD-Owned Solano Wind Project

102 MW capacity, adding 128MW by 2012

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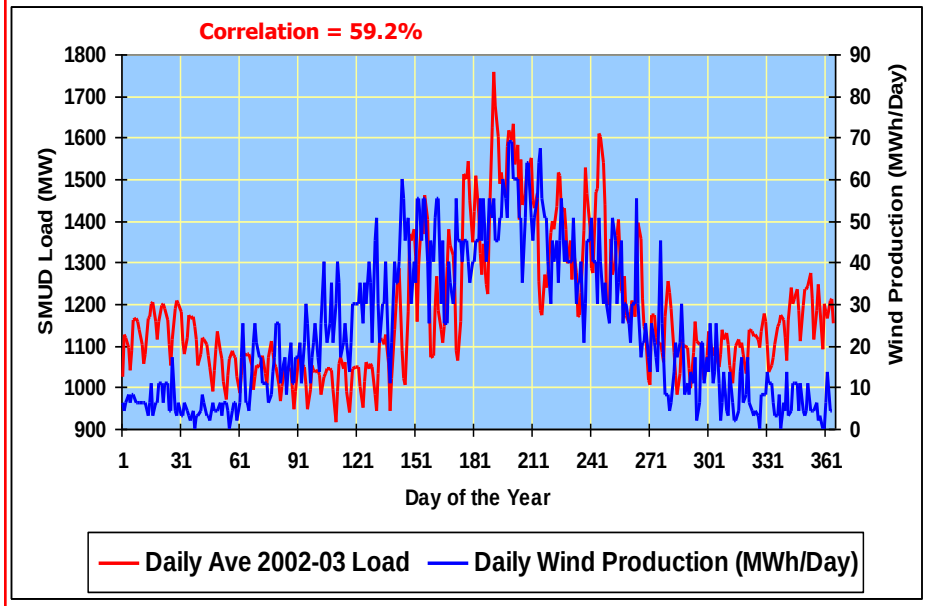
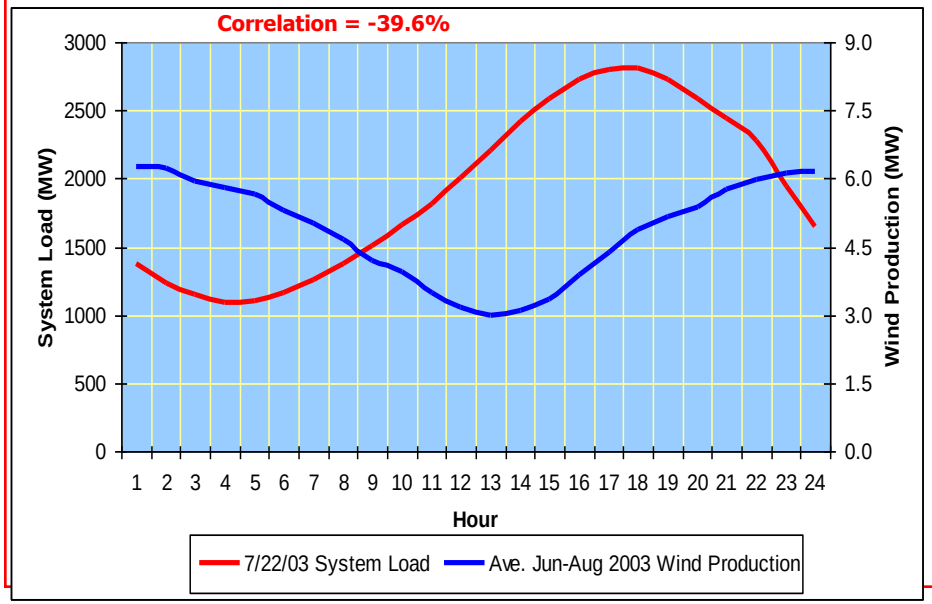
SMUD Wind Generation





- SMUD's peak load driven by hot summer temperatures
- Wind resource weakest on hottest days
- Comparing daily and hourly system load with Solano Wind Plant production illustrates mismatch
- Must rely on firming resources to address mismatch and ensure system stability

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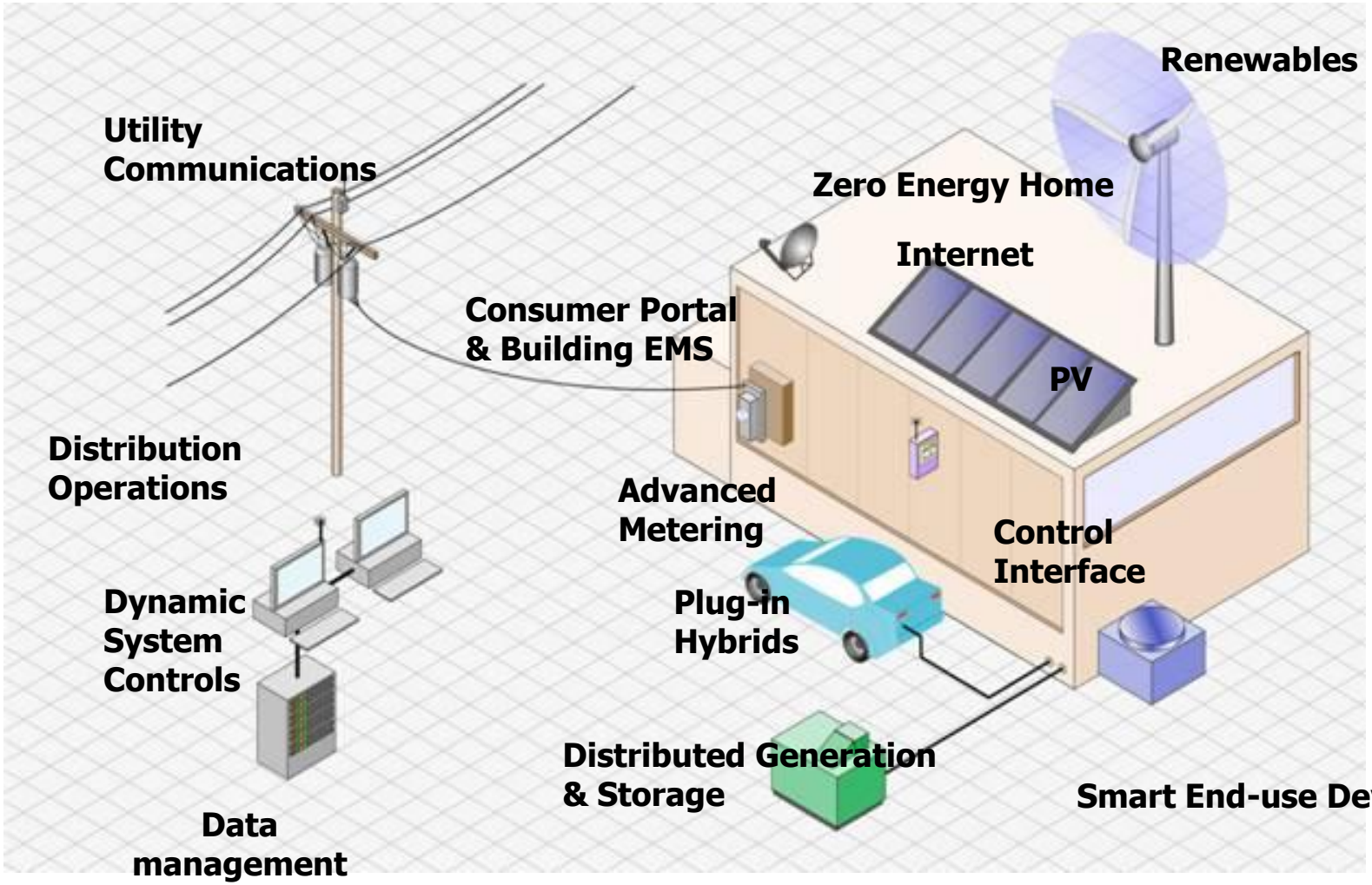
Smart Grid Vision



Source: EPRI

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SMUD Smart Grid Elements

- Distribution System Smartening
  - Upgrade for distribution system automation, loss prevention
- AMI
  - Communications with distribution system & end uses
  - SMUD Contracts awarded in June – Pilot Acceptance Testing with 50,000 households begins Oct.2009
- Demand Response
  - System and targeted load control
  - Price response
- Distributed Generation (time and eventually location based)
  - PV
  - Biomass
  - CHP
  - Plug-In Hybrids
  - Storage
- Zero Energy Smart Homes/Businesses/Municipal Structures
  - Combines all of the above

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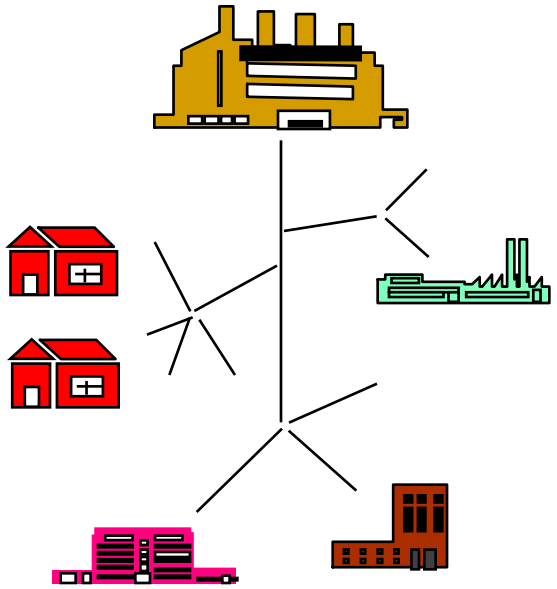
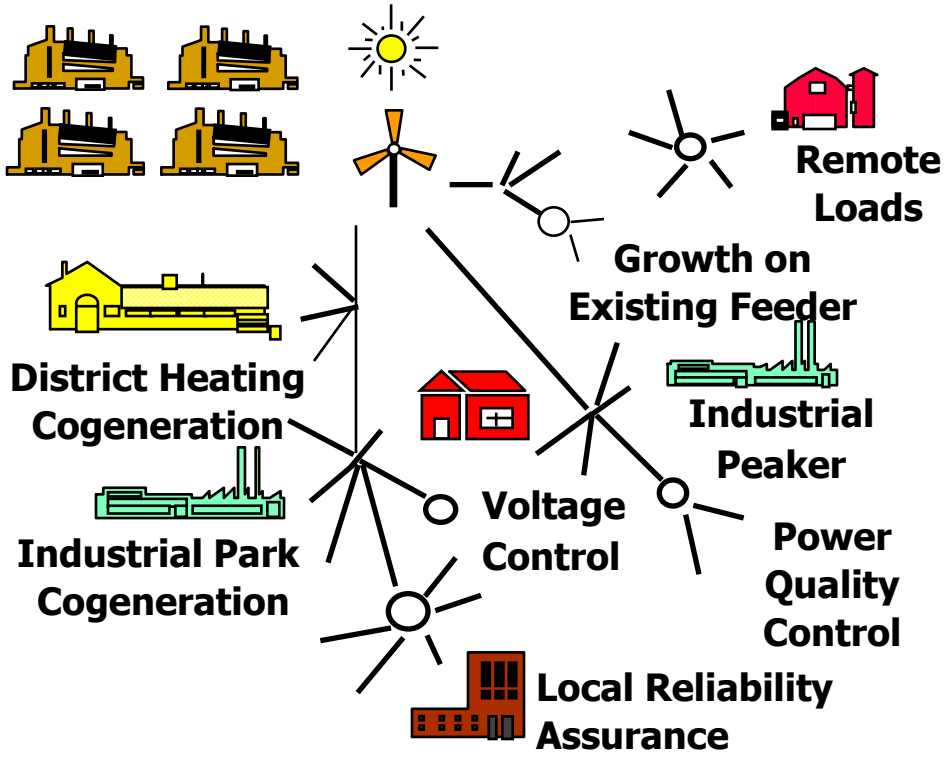
Distributed Utility Vision - Late 1980's

Borrowed from George Hay, NJ RESCO Workshop

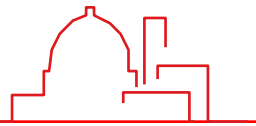
Fleet Today



Fleet Tomorrow



O = Modular dispersed generation and storage



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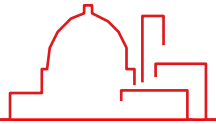
Biomass/AD:
Promising Distributed Generation

- Biomass Availability: Dairies, grease, food waste, landfills, fuel-loaded forests, agricultural waste
- Benefits:
  - Can be baseload power, high availability
  - Balance out renewable generation with intermittent availability
  - Generation can be located where the fuel is, minimizing transportation costs, increasing societal efficiencies
  - Helps meet renewable targets without need for new transmission
  - Generation close to the load, avoids losses
  - Reliability benefit to customer in outage
  - Additional local environmental and economic benefits…
- Requires: Financial Incentives, Net Metering, Proposed Feed-In Tariff (FIT), Technical & Regulatory Support



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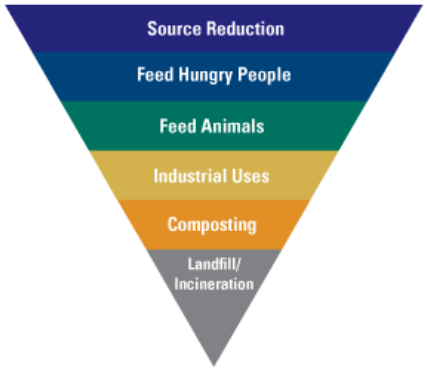
SMUD's Local Biomass Program

- *Problem wastes* used as resources in local waste-to-energy projects
  - Sustainable fuel supply
  - Mature or commercial-ready technologies
  - Dairy manure, grease, food, landfills, fuel-loaded forests
- Promote global and local environmental benefits
  - Reduce GHG emissions
  - Divert waste from landfills
  - Encourage alternative waste disposal methods
  - Reduce groundwater contamination
- Bring local economic benefits
  - Promote the creation of local jobs
  - Source of steady income to local business through electricity sales
- Leverage existing infrastructure where possible
  - Wastewater treatment plants
  - Landfills

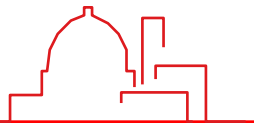


To solve our own regulatory barrier, we adopted a Biomass Net Metering Rate (at retail) in March 2005

MSW/Biomass Project Evaluation Criteria

- Proposal supports CIWMB and EPA policy / hierarchies of waste management
  - No interference with source reduction, reuse and recycling programs
- Proposal supports SMUD's Biomass program goals
- Site secured, permitted or with a clear permitting pathway
- Waste secured with reasonable supply certainty (i.e., not 100% of available)
- Price reasonable (not too high or too low as to be unrealistic)
- Technology certified by CEC as an "eligible renewable energy" for RPS
- Technology demonstrated at similar scale for more than 1 year with reliable, safe and predictable performance in operation
- Technology needs to have demonstrated it can meet environmental permitting levels
- Proposer needs to have experience (track record) with permitting and building projects of similar scale
- Proposer needs to have qualifications and a legal right to represent the technology
- Proposer needs to have developed a public input/outreach and education plan, particularly if there is opposition to the technology

SMUD AD & Related Projects



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Biogas Enhancement Pilot Test

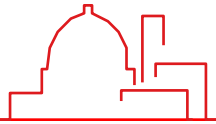
- Joint project with SRCSD at Sacramento Regional Wastewater Treatment Plant – Biogas already used at SMUD Co-Gen
- Utilizes excess capacity at largest inland water discharger in CA (181 mgd permitted capacity)
- Study Objectives:
  - Pump food processing waste and brown grease directly into the digester instead of primary and secondary treatment systems.
  - Increase gas production and methane content of the gas produced in the digesters.
  - Monitor biosolids characteristics in the digester, and potential operational issues for a full scale system
  - Obtain data on the economic factors to better assess economic feasibility of a full scale project
- Pilot Test conducted in four phases: Dec. 2008 – September 200

Dairy Digester Benefits

- Stabilize manure wastes, reducing odor and flies
- Digesters help mitigate GHG emissions, in accordance with CA AB-32
  - Two built digesters will capture and destroy ~ 7,430 tonnes/year CO_{2e}
- Reduce emissions of volatile organic compounds (VOCs), a smog precursor
- Steady revenue source for the farmer through electricity sales
- Effluent liquid can be used as a crop fertilizer, reducing the need for chemical fertilizers
- Digested solids are virtually pathogen free and may be sold for animal bedding or compost

SMUD's Dairy Digester Program

Old (2004 to 2009)	New (2009 to present)
Provided help to get grants --50% the USDA grant application cost, SMUD provided 13% capital cost incentive to match 25% USDA grant Developed a list of approved digester developers	Provides help to get grants
Major help with permitting and interconnection	Minor assistance in permitting requirements & interconnection
Net metering - crediting at retail rates	"Paradigm shift" - Developers build, permit, own, operate (or transfer) digester engine genset with co-digestion and CHP applications
Power Purchase Agreement for surplus electricity	Power Purchase Agreement using Feed-in Tariff Rates



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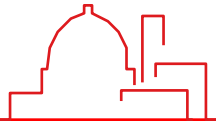
A Tale of Two Dairies…

- Cal-Denier Dairy (July 2008)
  - 500 milk cow dairy farm north of Galt
  - Flush manure management method
  - Flushed manure held in a holding pond
  - Ambient temperature, covered lagoon digester
  - Biogas sent to a 65 kW baseload engine/generator
- Tollenaar Dairy (April 2009)
  - 850 milk cow dairy farm
  - Farm grows a portion of the feed for their cows
  - Several methods adopted to reduce farm's water usage, making it possible for an advanced dairy digester called a "complete mix heated digester" to be built
  - Biogas to be burned at two 212 kW gensets

… FOUR years from start to commissioning



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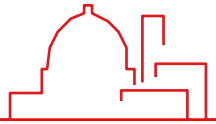
Air Emissions Permitting Issues

- Long delay in obtaining permit
  - ATC application deemed incomplete three times over 8 months
- Permitting process main issues:
  - SMAQMD did not have a BACT determination for IC engines running on biogas
  - Dairy required to submit cost information for SCR to meet 9 ppm NO_x and H_2S scrubber to meet 50 ppm of SO_2
- Resolution
  - Applicant installed smaller (212 kW) engine guaranteed to meet 10 lb/day NO_x limit, and H_2S scrubber to meet SMAQMD's 10 lb/day SO_2
  - Applicant submits application for second 212 kW engine, considered two separate and independent units:
    - One exclusively supplies power to the grid; the other supplies power to the farm
    - Each engine has to meet the 10 lb/day threshold for NO_x and SO_x

New Diary Projects Planned

Objective: Demonstrate and deploy new and advanced digesters that will employ **double -lined covered lagoon** and **low NOx Greenguard™ engine** at New Hope Dairy and **above ground complete mix** using **fuel cell** at Warmerdam Dairy both for CHP applications.

	New Hope Dairy	Warmerdam Dairy
Milking Cows	**1,050**	**1,100**
Engine Size	**500 kW**	**1,000 kW**
Type of Prime Mover	**Low NOx Greenguard™ Engine**	**Fuel Cell**
Expected Start of Operation	**Q4 2011**	**Q4 2011**
Digester Type	**Covered Lagoon (double liner)**	**Complete Mix (above ground)**
Partners	**USDOE, CEC, SMUD, Williams Engineering, CalBio, New Hope Dairy**	**USDOE, CEC, SMUD, Innate Energy, Warmerdam Dairy**



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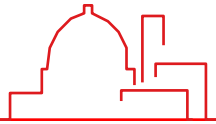
Technical Solutions

- Assessing practical, cost-effective, emission control technologies for use in dairy digester gas, landfill gas, digester gas, and other applications
- Demonstrating novel H_2S and NO_x reduction technologies at Tollenaar (carbon bed) through CEC-ICAT grant
- Part of a team working to demonstrate other technologies (H_2 blending with biogas, engine emission control) in large dairies
- Pipeline Injection
- Supporting development of programmatic EIR for manure digestion and co-digestion with Regional Water Board, CARB, PG&E, CPUC, SJVAPCD, SCAMD, WUD, other Industry partners



Other Potential AD Projects

- DOE Community Renewable Energy Deployment Grant ($5M)
  - Community Digester - Location TBD
  - Two new dairy digesters
  - Permanent Co-digestion Facility
- Other possibilities
  - Folsom Prison AD / Fuel Cell
  - Campbell's Soup
- Additives R&D to enhance biogas production (see Zeynep Erdal, CH2M Hill, 4/14)

Our newest incentive…

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SMUD's New Feed-in Tariff

- Approved with rate action, June 2009
- Effective January, 2010
- Distributed Generation Projects < 5MW
  - First Come, First Served, up to 100MW of generation
- Separate rates for fossil-based CHP and Renewable sources (10, 15 & 20 year terms)
- Adjusted for time-of delivery
- Represents value of the generation to SMUD
  - Capacity benefits
  - Transmission savings
  - RECs
  - GHG reduction value
- Fully subscribed immediately – all PV projects

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Proposed* Feed-in Tariff for Eligible Renewable Generation (nominal $/kwh)

Start Year	Term	Time of Delivery Period									
		Winter Off-Peak	Winter On-Peak	Winter Super-Peak	Spring Off-Peak	Spring On-Peak	Spring Super-Peak	Summer Off-Peak	Summer On-Peak	Summer Super-Peak	Annual Average
2010	10-Year	$0.0828	$0.0999	$0.1197	$0.0717	$0.0875	$0.0929	$0.0854	$0.0949	$0.2709	$0.1030
	15-Year	$0.0900	$0.1081	$0.1285	$0.0780	$0.0943	$0.1000	$0.0928	$0.1026	$0.2851	$0.1109
	20-Year	$0.0981	$0.1172	$0.1383	$0.0854	$0.1026	$0.1085	$0.1008	$0.1115	$0.2997	$0.1198
2011	10-Year	$0.0850	$0.1024	$0.1225	$0.0736	$0.0892	$0.0946	$0.0877	$0.0968	$0.2760	$0.1054
	15-Year	$0.0930	$0.1114	$0.1323	$0.0808	$0.0971	$0.1028	$0.0958	$0.1056	$0.2915	$0.1142
	20-Year	$0.1017	$0.1214	$0.1428	$0.0888	$0.1061	$0.1122	$0.1045	$0.1153	$0.3066	$0.1238
2012	10-Year	$0.0880	$0.1058	$0.1262	$0.0762	$0.0918	$0.0972	$0.0907	$0.0994	$0.2819	$0.1085
	15-Year	$0.0967	$0.1156	$0.1368	$0.0841	$0.1005	$0.1063	$0.0996	$0.1093	$0.2984	$0.1182
	20-Year	$0.1059	$0.1259	$0.1478	$0.0926	$0.1100	$0.1161	$0.1088	$0.1193	$0.3138	$0.1282

*Subject to final BOD approval

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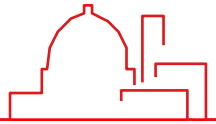
Experience with Barriers and Solutions

- Biomass projects are more expensive but worth it…
  - Biomass projects produce many external benefits that are not compensated
  - High transaction cost - projects require more handholding than others
  - Tradeoffs exist – there is no free lunch!
- Regulatory barriers to implementing projects
  - Projects themselves produce environmental benefits: odor reduction, renewable energy generation, improved protection of groundwater, greenhouse gas reduction
  - Most regulatory staff are aware of benefits and try to help
  - Despite the efforts, permitting requirements are contradictory, onerous, endless
- Dairy projects took 4 years to plan, construct and permit



Barriers and Solutions – On-site Generation

Problems

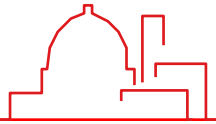
- Distributed electric generation and combined heat and power equals:
  - power where it is needed without new transmission
  - greater efficiency than central plants
- Cannot meet central plant emission levels
  - Lacks cost-effective or proven low emission engine technology
  - Lacks cost-effective or proven gas cleanup technology

Solutions

- State funded research on emission reduction technology improvements
- Flexible permitting using available technologies while progress is made
- State policies to credit projects with **net benefit** exchange between NOx and Greenhouse gas emissions

Tradeoff

- If 50% of CA dairies adopted digester technology, NOx emission would be 98 tons. Greenhouse gas reduction would be 4.4 million tons.



Barriers and Solutions – Codigestion

Problems

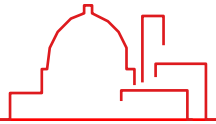
- Food waste in on-farm codigesters is a good resource for energy and soil nutrients, but produces negative environmental impacts in landfills
- Elemental salts in manure and in food waste are retained during codigestion, but easily identified and predicable
- State regulators are only beginning to understand salt management so their tendency is to just say no

Solutions

- State should escalate effort on Salinity Working Group to develop guidelines for salt application rates to farmland
- State should support research manure management with codigestion

Tradeoff

- Codigestion of 20% food waste can double energy production and provide the farmer with revenue that supports digester projects without government funding. Codigestion adds to complexity of nutrient management.



Barriers and Solutions – MSW

Problems

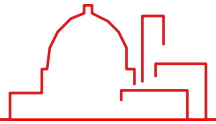
- Current definition for gasification requires zero oxygen or air and zero emissions to air or water, which is impractical and held to higher standard than any other entity

Solutions

- Legislature needs to correct errors in the definition of gasification.
- State should support research and demonstration using fees from landfill

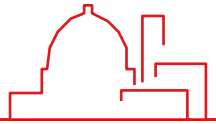
Tradeoff

- Getting organics out of landfills will protect water and reduce fugitive greenhouse gas emissions. Some emissions will result from conversion technologies.



Barriers / Help Needed

- Collection Programs!
- Relatively low cost of landfill (in short term)
- Co-digestion, Materials Handling – Solid Waste Permitting
- NOX Emissions – Air Permitting
- Effluent – Water Permitting
- Community Objections...DG is new/old ground



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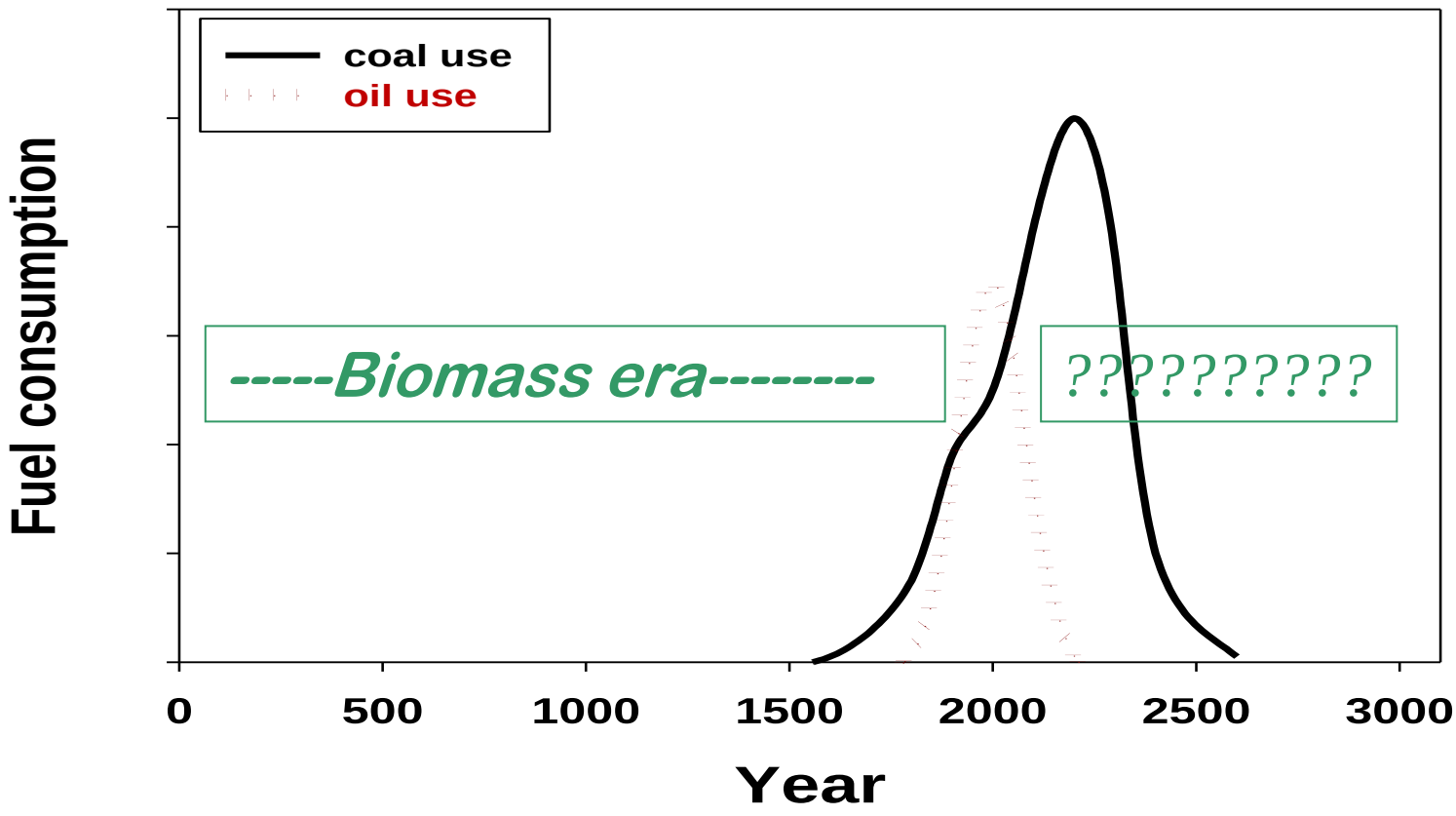

Expected duration of fossil fuels (0 to 3000 AD)

(redrawn from P.E. Hodgson, 1999)

Courtesy of Steven Kaffka, Director, CA Biomass Collaborative

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Thank you!

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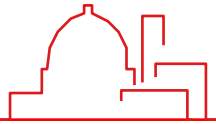

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