Rialto Bioenergy Facility
Integrated Organics Recycling and Bioenergy Production
Agenda

- Drivers for Food Waste Diversion, Biosolids Processing, and Bioenergy
- Centralized Approach to Organics Recycling
- A sustainable outlet for Southern California Biosolids to produce:
  - Class A biosolids
  - Biochar
  - Renewable energy

Opportunity: Divert **300 TPD** of Biosolids to Rialto Bioenergy Facility to Develop a Sustainable Local Outlet and Recover Renewable Energy from Biosolids
California Mandates Food Waste Diversion from Landfill

SB 1383: Goal 75% landfill diversion by 2025
California Mandates Bioenergy Production

SB 1122 requires 110 MW renewable electricity procured from bioenergy
Biosolids Land Application & Landfilling is Increasingly Difficult

797,000 dry tons of Biosolids in 2013
2/3rd land applied, 1/3rd landfilled

Increasing bans and regulations on land application
Rialto Bioenergy Process Diagram

**FOOD WASTE**
- MSW → OREX → Dry Fraction
- Organics → Hauling → Up to 700 TPD
- Anaerobic Digestion
- Biogas → Biogas Conversion
- Electricity → Up to 5 MW
- Renewable Gas Injection → Up to 600,000 MMBTU/yr

**BIOSOLIDS**
- Wastewater Treatment
- Dewatered Biosolids → Hauling → Up to 450 TPD
- Digestate Drying & Thermal Enhancement
- Urban Fertilizer
Rialto Is A Long Term Renewable Energy Outlet That The Region Needs

Table 2

<table>
<thead>
<tr>
<th>Biosolids Management Options (by Volume)</th>
<th>2015/16</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting</td>
<td>48%</td>
<td>32%</td>
</tr>
<tr>
<td>Land Application</td>
<td>35%</td>
<td>51%</td>
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<tr>
<td>Landfill</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Mine Reclamation</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Biofuel</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Pellets/Fertilizer</td>
<td>&lt; 0%</td>
<td>2%</td>
</tr>
<tr>
<td>Deep Well Injection</td>
<td>&lt; 0%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Main Challenges Agencies Face with Biosolids Recycling

Table 8

<table>
<thead>
<tr>
<th>Agencies Main Challenges</th>
<th>Reported in 2010</th>
<th>Reported in 2012</th>
<th>Reported in 2014 *</th>
<th>Reported in 2016</th>
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<tbody>
<tr>
<td>Rising Costs</td>
<td>13</td>
<td>10</td>
<td>17</td>
<td>10</td>
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<tr>
<td>Public Perception/Relations</td>
<td>3</td>
<td>5</td>
<td>12</td>
<td>2</td>
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<tr>
<td>Finding Low Cost Local Mgmt Options</td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>8</td>
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<tr>
<td>Space for Drying Operations</td>
<td>3</td>
<td>1</td>
<td>12</td>
<td>2</td>
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<tr>
<td>Regulatory Restrictions</td>
<td>3</td>
<td>3</td>
<td>14</td>
<td>3</td>
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<tr>
<td>Securing Long Term Disposal Options</td>
<td>3</td>
<td>8</td>
<td>19</td>
<td>7</td>
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<tr>
<td>Wet Weather Drying Operations</td>
<td>3</td>
<td>3</td>
<td>12</td>
<td>2</td>
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</tbody>
</table>

*2014 includes all concerns reported whereas other years only includes number one concern.
### Agencies Plans for Biosolids in Next 5 Years

<table>
<thead>
<tr>
<th>Management Option</th>
<th>Reported in 2016</th>
<th>Reported in 2014</th>
<th>Reported in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting</td>
<td>10</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Landfill</td>
<td>6</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Land Application</td>
<td>4</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Evaluate Alternatives</td>
<td>4</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Investigate Dewatering Options</td>
<td>4</td>
<td>3</td>
<td>2</td>
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<tr>
<td>Evaluation of Class A or B</td>
<td>3</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Utilize Food Waste</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Heat Drying/Pelletizing</td>
<td>2</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Expand Market for Use of Pellets</td>
<td>1</td>
<td>2</td>
<td>0</td>
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<tr>
<td>Deep Well Injection</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Incineration</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bio-fuel Production</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Gasification/Energy Production</td>
<td>0</td>
<td>1</td>
<td>1</td>
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</table>
**Rialto Bioenergy Facility Status**

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Owned By Anaergia</td>
<td>Complete</td>
</tr>
<tr>
<td>Lease Agreement with City of Rialto</td>
<td>Complete</td>
</tr>
<tr>
<td>CEQA/NEPA</td>
<td>In Progress, Completion Feb. 2018</td>
</tr>
<tr>
<td>Air Permit</td>
<td>In Progress, to be filed in Feb 2018</td>
</tr>
<tr>
<td>Feedstock - Food Waste #1</td>
<td>In Progress, Completion Oct. 2017</td>
</tr>
<tr>
<td>Offtake #1 Electricity</td>
<td>In Progress, Mandatory Process</td>
</tr>
<tr>
<td>Offtake #2 Biomethane</td>
<td>In Progress, Completion Nov. 2018</td>
</tr>
<tr>
<td><strong>Feedstock #2 – 300 TPD Biosolids</strong></td>
<td><strong>Need by Q2 2018</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grant Source</th>
<th>Amount ($M)</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Department of Energy</td>
<td>17</td>
<td>Dryer &amp; Pyrolysis</td>
</tr>
<tr>
<td>Calrecycle</td>
<td>4</td>
<td>Anaerobic Digester</td>
</tr>
<tr>
<td>California Energy Comission</td>
<td>3</td>
<td>Biomethane for Pipeline</td>
</tr>
</tbody>
</table>
Grant from U.S. Department of Energy (up to $17M) for Biosolids Processing

Energy Department Announces Six Projects for Pilot- and Demonstration-Scale Manufacturing of Biofuels, Bioproducts, and Biopower

December 28, 2016 - 2:11pm

Today, the Energy Department (DOE) announced the selection of six projects for up to $12.9 million in federal funding, entitled “Project Definition for Pilot- and Demonstration-Scale Manufacturing of Biofuels, Bioproducts, and Biopower.” These projects, required to share the cost at a minimum of 50%, will develop and execute plans for the manufacturing of advanced and cellulosic biofuels, bioproducts, refinery-compatible intermediates, and/or biopower in a domestic pilot- or demonstration-scale integrated biorefinery.

The projects will be evaluated in two phases. Award recipients will design and plan their facilities in Phase 1. In order to continue to Phase 2, projects will be evaluated on Phase 1 progress, as well as the ability to secure the required 50% cost share funding for Phase 2. DOE anticipates Phase 2 awards to be made in fiscal year 2018 to construct and operate the pilot- or demonstration-scale facility. Projects could receive additional federal funds of up to $15 million for pilot-scale facilities or $45 million for demonstration-scale facilities.

The six Phase 1 projects will utilize thermochemical, biochemical, algal, and hybrid conversion technologies to generate the data required to enable future commercial-scale facilities.

Pilot-Scale Waste-to-Energy Projects:

- **Rialto Bioenergy, LLC (Carlsbad, California):** Rialto Bioenergy LLC ($2 million) plans to design the Rialto Advanced Pyrolysis Integrated Biorefinery facility that will have the capacity to convert 300 tons per day of biomass such as food extracted from municipal solid waste and wastewater treatment plant biosolids into a high-nutrient fertilizer and up to 6.4 megawatts of carbon-negative, renewable biopower.
Organics Recovery Options

Source Separated Organics
- Rely on human behavior
- Outreach, education
- Dedicated collection
- New bins

Centralized Processing
- No behavior change
- Same collection routes
- Same trucks

Anaergia
Anaergia OREX 1000
Organics Extrusion

Benefits
• Flexible to process any waste
• Process any contamination level
• Remove contaminants with filtering action of plug (vs. hammer or shear)
• No dilution required
• Produce clean organic stream suitable for digestion or compost
OREX in San Francisco
Organics Extracted from MSW in San Francisco
Organics From MSW Delivered to Anaerobic Digesters at EBMUD
Centralized Organics Management Offers Flexible Outlets

Wastewater Treatment Plant
- Wastewater
- Anaerobic Digestion

Merchant Digestion Plant
- Organics Polishing
- Anaerobic Digestion

Compost

OREX
- Commercial Waste
- Residential Waste
- SSO

Dry Fraction

Hauling

Wet Fraction

Material Recovery
Flexible to Produce Cake or Slurry

30% Solids

20% Solids

14% Solids
Centralized Organics Recovery is More Cost Effective Than SSO

### Source Separated Organics

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost/ton</th>
<th>Diverted</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>OPEX for Processing</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Collection and transfer</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Outreach, education, enforcement</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Composting Tip Fee Less Current T&amp;D to Landfill</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>282</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Centralized Processing

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost/ton</th>
<th>Diverted</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>OPEX for Processing</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>WWTP Tip Fee Less Current T&amp;D to Landfill</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Third party study by Golder Associates Inc. for Northern California Solid Waste Hauler
Organics Diversion to Anaerobic Digestions Reduces GHG Footprint

Global warming emissions can be significantly reduced by diverting organic material from municipal solid waste that would otherwise go to landfills. Anaerobic digestion can even result in negative global warming emissions.

Note: Life cycle emissions can vary widely depending on the specific system configuration and actual alternative waste fates.

OREX 1000 in Italy - SSO
OREX1000 in South Africa
Rialto BioEnergy Facility
Rialto Bioenergy Facility Site

Rialto WWTP

RBF
Rialto Bioenergy Facility Site

Aerial Photo of the Mothballed Enertec Facility
RBF Leverages Existing Assets
Rialto Bioenergy Facility Site

Rendering of the Future Rialto Bioenergy Facility Site at Full Build Out
Reception Bins
Reception Bins
Organics From MSW Delivered to Anaerobic Digesters
Cake & Organics High Pressure Piston Pumps
Storage Silos
Wet Fraction Polished at Rialto

Organics Extraction

(1) OREX

Dry fraction
>90% organics recovered

Organics Polishing

(2a) DYNAMIC CYCLONE

Floatable Material
>90% floatables removed

(2b) HYDROCLYCONE

Grit
>85% grit removed

Anaerobic Digestion

(3) DIGESTERS

Clean Digestate

MSW

Wet

Clean Digestate

Organics Polishing

Anaerobic Digestion

Wet fraction

Dry fraction

Wet fraction

Dry fraction

>90% organics recovered

>90% floatables removed

>85% grit removed

>90% floatables removed

>85% grit removed

Clean Digestate

Clean Digestate

Clean Digestate

Clean Digestate

Clean Digestate

Clean Digestate
Organics Polishing System (OPS)

Dynamic Cyclones
Organics Polishing System (OPS)
Organics Polishing System (OPS)
Organics Polishing System (OPS)

Unpolished Organics

Polished Organics
Organics Polishing System (OPS) - HydroCyclone & Grit Washer
Organics Polishing System (OPS) - HydroCyclone & Grit Washer

1. Organics Feed
2. Screened Grit
3. Grit Free Waste Water
4. Feed to Digesters

Grit Discharge
High Solids Anaerobic Digester (HSAD)

Anaerobic Digesters
High Solids Anaerobic Digester (HSAD)

High Solids Food Waste Digester – Dagenham, UK
High Solids Anaerobic Digester (HSAD)

- Energy efficient high solids electric mixers
- Easy Access for Repositioning or Service without Biogas Loss
Solids Belt Dryer
Solids Belt Dryer
Solids Belt Dryer

1 = granulating unit
2 = plate belt made of stainless steel
3 = turning unit
4 = water-cooled discharge screw
Pyrolyzer
Pyrolyzer

Biochar derived from pyrolysis
Pyrolyzer

Bio-oil derived from pyrolysis
Combined Heat & Power (CHP) Engine Generators
Combined Heat & Power (CHP) Engine Generators

2X 800 kW Biogas CHPs in CA
Pyrolysis Increases Biogas Production and Improves Biosolids Value:
Less Residual Mass, Higher Value, More Biogas

Diagram:
- Anaerobic Digester
- Drying
- Pyrolysis
- Cake
- Dry Solid
- Char
- Gas
- Oil

Biogas Flow:
- Anaerobic Digester → Drying → Pyrolysis
- Cake → Dry Solid → Char
- Gas → Oil
Pyrolysis at Encina Wastewater Authority
Pyrolysis Increases Biogas Production and Improves Biosolids Value:
Less Residual Mass, Higher Value, More Biogas

GREATER BIOSOLIDS QUALITY:
- Concentrates nutrients
- Increases biogas by >25%
- Reduces solids export by 8x
- Stabile product: less dust & odor
- Slow release nutrients, no leaching

Dried Biosolids

![Dried Biosolids Nutrient Composition]

Biochar

![Biochar Nutrient Composition]
Co-digesting Sludge with Pyrolysis Oil
Biochar
Pyrolyzer

Bio-oil derived from pyrolysis
Pyro-oil Produces Biogas in Digesters

Cumulative Gas Production vs Time

- **Dig. 1 (Control)**
- **Dig. 2 (Biosolids Oil)**

- 48% increase from control
- 34% increase from control
- 26% increase from control

Biogas (ft³)

Time (Days)

- **MORE ENERGY**
  - Increases biogas production by ~25% through co-digestion of oil & gas

- **FEWER SOLIDS**
  - Reduces mass of dewatered sludge by ~8X

- **HIGHER VALUE**
  - Solid char has higher fertilizer value
Thank You

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Yaniv.Scherson@Anaergia.com