Think Green.® Think Waste Management.

LMOP Conference
Waste To Wheels & California LCFS
January 20, 2011
Baltimore, Maryland

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Director of Regulatory Affairs/West
Waste Management
Today’s Presentation

• Waste Management’s Interest in Fuels
• Waste Management’s Shift to Natural Gas
• Regulatory Drivers for Change
  – Focus on Low Carbon Fuel Standard
• Waste Management’s Development of Renewable Natural Gas
Corporate Overview

- Headquartered in Houston, Texas
- Operations in 48 states, District of Columbia, Canada and Puerto Rico
- Nearly 20 million customers
- Collect about 66 million tons of waste
  - ~44 million tons organic waste
  - 273 active landfills
  - Approximately 367 collection operations
  - 103 recycling facilities
- More than 45,000 employees
367 WM Hauling Districts in North America

19,000 HDVs in North America
- 5000 HDVs in West
- 3000 HDVs in California
- 1000 NG HDVs
WM West Group Hauling Districts

- 4 CNG Facilities
  - 400 Trucks
- 8 Bio/LNG Facilities
  - 400 Trucks
  - Altamont Bio-LNG Facility
    - 13,000 Gal/day of Bio-LNG
- 5 LCNG Facilities in construction process

5000 HD Collection Vehicles in Western North America
WM’s CA Natural Gas Fleet (27% and growing!)

WM’s California Truck Fleet:
- Diesel – 2200
- LNG/CNG – 800
- Total -- 3000
California Drivers for RNG

- Cap and Trade Regulations Adopted
  - Potential Revenues for BioFuels
- Low Carbon Fuel Standard –
  - Starts January, 2011.
  - 10% reduction in fuel carbon intensity by 2020
- AB 118 – Alternative and Renewable Fuel and Vehicle Technology
  - Deploy innovative transportation fuels & technologies
  - CEC Funding ~ $100 million per year
- CAEATFA: SB 71 -- Sales and Use Tax Exclusion
  - Equipment to Generate Renewable Fuels

Today’s Focus!
2020 Projection – Business as Usual -- 600 MMTCO2e

1990 GHG emissions & 2020 limit is 427 MMTCO2e

Difference equals reduction goal
- Approximately 173 MMTCO2e
- Approximately 30% reduction from 2020 level
California Low Carbon Fuel Standard

- 10% Reduction in CA fuel carbon intensity by 2020
  - 2010 is baseline
  - All fuel producers
  - Reduction gradual and weighted to later years

- 16 MMTCO2e reductions expected by 2020
  - 10% of AB 32 target

- Increase use of biofuels, electricity & biodiesel
LCFS Carbon Intensity Standard

Compliance Schedule from 2011 to 2020 for Diesel Fuel or Diesel Fuel Substitutes

- Initially Slow Intensity Decline
- Later Faster Decline

10% Reduction in Carbon Intensity

Source: CARB LCFS Staff Report -- March, 2009
Fuel “Well to Wheels” LifeCycle -- Diesel

Oil Well: 7 g/MJ
Transportation: 1 g/MJ
Refinery: 14 g/MJ
Transportation: 1 g/MJ
Vehicle: 73 g/MJ

Source: CARB LCFS Staff Presentation -- April, 2009
Fuel “Field to Wheels” LifeCycle – Corn Ethanol

- Corn Field: 36 g/MJ
- Land Use Change: 30 g/MJ
- Bio-Refinery: 38 g/MJ
- Transportation: 2 g/MJ
- Land Use Change: 30 g/MJ
- Blend with gasoline: -12 g/MJ
- Emissions are Offset
- Vehicles:

Corn Ethanol 97 g/MJ

Source: CARB LCFS Staff Presentation -- April, 2009
Fuel "Waste to Wheels" LifeCycle – Waste Biomass

- Corn Field: 36 g/MJ
  - Transportation: 2 g/MJ
  - Land Use Change: 30 g/MJ

- Bio-Refinery: 38 g/MJ
  - Transportation: 3 g/MJ
  - Blend with gasoline

- Vehicles: Emissions are Offset
- Co-Products: Waste-Based Ultra Low Carbon Fuel

Source: CARB LCFS Staff Presentation -- April, 2009
LCFS Life-Cycle Assessment of LFG to LNG

Uncontrolled Emissions

Collected LFG (75%)

Fuel Production

T&D

PTW

What About Fugitive Emissions?

Source: Argonne National Laboratory
Carbon Intensity of Alternative Fuels

WTW GHG Emissions

WOW!! Look at Landfill Biogas!!
## Comparison of LCFS Fuel Carbon Intensities (gCO2e/MJ)

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Direct WTW Emissions</th>
<th>Indirect Emissions</th>
<th>Total Emissions</th>
<th>% of Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline (CARBOB)</td>
<td>95.86</td>
<td>0</td>
<td>95.86</td>
<td>101</td>
</tr>
<tr>
<td>Diesel (ULSD)</td>
<td>94.71</td>
<td>0</td>
<td>94.71</td>
<td>100</td>
</tr>
<tr>
<td>Ethanol (Midwest WetMill Coal)</td>
<td>90.99</td>
<td>30</td>
<td>120.99</td>
<td>128</td>
</tr>
<tr>
<td>Ethanol (Dry Mill Proprietary)</td>
<td>43.20</td>
<td>30</td>
<td>73.20</td>
<td>77</td>
</tr>
<tr>
<td>Ethanol (Brazilian Sugarcane)</td>
<td>25.94</td>
<td>46</td>
<td>71.94</td>
<td>76</td>
</tr>
<tr>
<td>Biodiesel (Midwest Soybeans)</td>
<td>21.25</td>
<td>62</td>
<td>83.25</td>
<td>88</td>
</tr>
<tr>
<td><strong>Biodiesel (Waste Cooking Oils)</strong></td>
<td><strong>15.84</strong></td>
<td>0</td>
<td><strong>15.84</strong></td>
<td><strong>17</strong></td>
</tr>
<tr>
<td><strong>Biodiesel (Waste Corn Oil)</strong></td>
<td><strong>5.90</strong></td>
<td>0</td>
<td><strong>5.90</strong></td>
<td><strong>6</strong></td>
</tr>
<tr>
<td><strong>Renew-Diesel (Waste Tallow)</strong></td>
<td><strong>19.65</strong></td>
<td>0</td>
<td><strong>19.65</strong></td>
<td><strong>21</strong></td>
</tr>
<tr>
<td>CNG (NA Fossil, CA Compressed)</td>
<td>68.00</td>
<td>0</td>
<td>68.00</td>
<td>72</td>
</tr>
<tr>
<td><strong>Renewable CNG (Landfill)</strong></td>
<td><strong>11.26</strong>*</td>
<td>0</td>
<td><strong>11.26</strong>*</td>
<td><strong>13</strong>*</td>
</tr>
<tr>
<td><strong>Renewable LNG (Landfill)</strong></td>
<td><strong>15.56</strong>*</td>
<td>0</td>
<td><strong>15.56</strong>*</td>
<td><strong>16</strong>*</td>
</tr>
</tbody>
</table>

* Assumes use of Grid Power, Not Site Power. Use of Onsite LFG Power should lower CI by additional ~10%
Are Even Lower Carbon Fuels Possible?

Does Diversion of Waste From LF Result in Avoided Emissions as part of LCFS?

Landfill Diversion with Conversion Technology

Modified from Original:

Argonne National Laboratory
Think Green.® Think Waste Management.

So **What** is WM Doing About All This

???????????
Gee... Where Can We Find BioGas?

- Landfill Anaerobic Decomposition of Organic Waste = Biogenic
- About half METHANE and half CARBON DIOXIDE as produced in the waste
- Nitrogen and Oxygen introduced by air intrusion
- 450 to 550 BTU per cubic foot of landfill gas
- Flow will increase while landfill is still open, and decrease when landfill closes
• Recovery and Utilization of Biomethane Landfill Gas for Transportation Fuel
• Altamont Landfill & Recycling Center, Fall 2009
• $15.5 million capital investment
• 13,000 Bio-LNG Gallons/day
• “Super Ultra Low Carbon Fuel” – lowest in CA
• Largest effort to introduce onsite liquefaction for landfill gas recovery in North America
• Utilize biogas resources and displace fossil fuels
• 2nd Plant planned for SoCal
• LFG to Pipeline CNG?
Process & Instrument Diagram

Talk to Linde Group for Details

Bottom Line: It’s Complicated & Expensive
Opportunity/Challenge: Fossil Fuel Price

Natural Gas Spot 5 Years - $/mmBTU

Diesel Fuel Prices: Nominal and Real

Short Term Energy Outlook - July 2010
What does LCFS mean to Altamont LFG to RLNG?

- 13,000 Gallons of RLNG/yr = 4.75 million gallons/yr
  - = 400,000 MMBTU/yr @ 84,000 BTU/gal
  - = -33,300 MTCO2e/yr LCFS GHG Credits

- What is the Value of Carbon?
  - @ $5/MTCO2e = $166,500/year
  - @ $10/MTCO2e = $333,000/year
  - @ $20/MTCO2e = $666,000/year
  - @ $30/MTCO2e = $1 million/year

- What is the Value of the Fuel?
  - $4.50/MMBTU x 400,000 MMBTU/yr = $1.8 million/year
    - Therefore, a 9% to 55% potential revenue boost
What About LFG to Pipelines?

- Cheaper, More Efficient & Reliable
- Readily Available Low Carbon Energy
  - >20 existing projects nationwide
- State Laws may Restrict
  - California
    - Hayden Statute
    - CPUC Tariffs currently prohibit
    - GHG C&T and Reporting
- California Utility Concerns
  - Liability, Corrosion & Contaminants
    - moisture, sulfur, O₂, vinyl chloride, siloxanes, etc.
- Pending GTI Study to raise confidence of Treatment & Monitoring Technology?
Anaerobic Digestion

The dry fermentation process anaerobically (without oxygen) digests waste material to produce methane over a 28-day period.

1) Waste material placed in an air-tight building for 28 days (typically 50/50 mix of yard/food waste)
2) Percolate and bacteria recirculated during digestion
3) Biogas collected and extracted at top of building,
4) Methane Gas cleaned and sold or burned for electricity
Thermo-chemical gasification to produce syngas which converts into fuels & biochemicals.
S4 Energy Solutions, LLC

- S4 Energy Solutions uses advanced plasma gasification technology to recover energy and useful by-products from waste.
- 25 tons-per-day commercial design at Columbia Ridge Landfill, OR; Project phases:
  - Small scale plant design and construction
  - Scale up and commercial strategy
- Goal of 125 – 250 TPD plants in a distributed model that process MSW and other waste materials.
In Summary . . .

• What are drivers for energy/fuel from waste?
  – Fossil Fuel Prices
  – GHG & Renewable Fuel Regulations (LCFS, C&T, RFS)
  – Fiscal Incentives (AB 118, CAEATFA)

• What is WM currently doing?
  – Expanding NG Fleet
  – Expanding LFG to Energy/Fuels
  – Investing in State of the Art Technologies

• What are the technologies of the future?
  – Landfill Gas is “low hanging fruit” – here today !!
  – Anaerobic Digestion (RACs, Harvest Power)
  – Gasification (Enerkem, S4)
Any Questions?