

Think Green.® Think Waste Management.



Collection



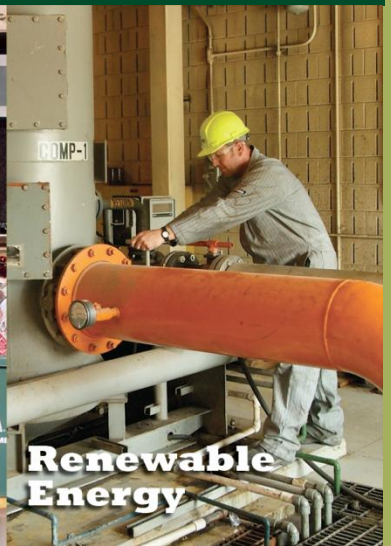
Transfer



Disposal



Recycling



Renewable Energy

SoCalGas Renewable Natural Gas Seminar Closing the Loop on Renewable Fuel June 14, 2011 Los Angeles, California

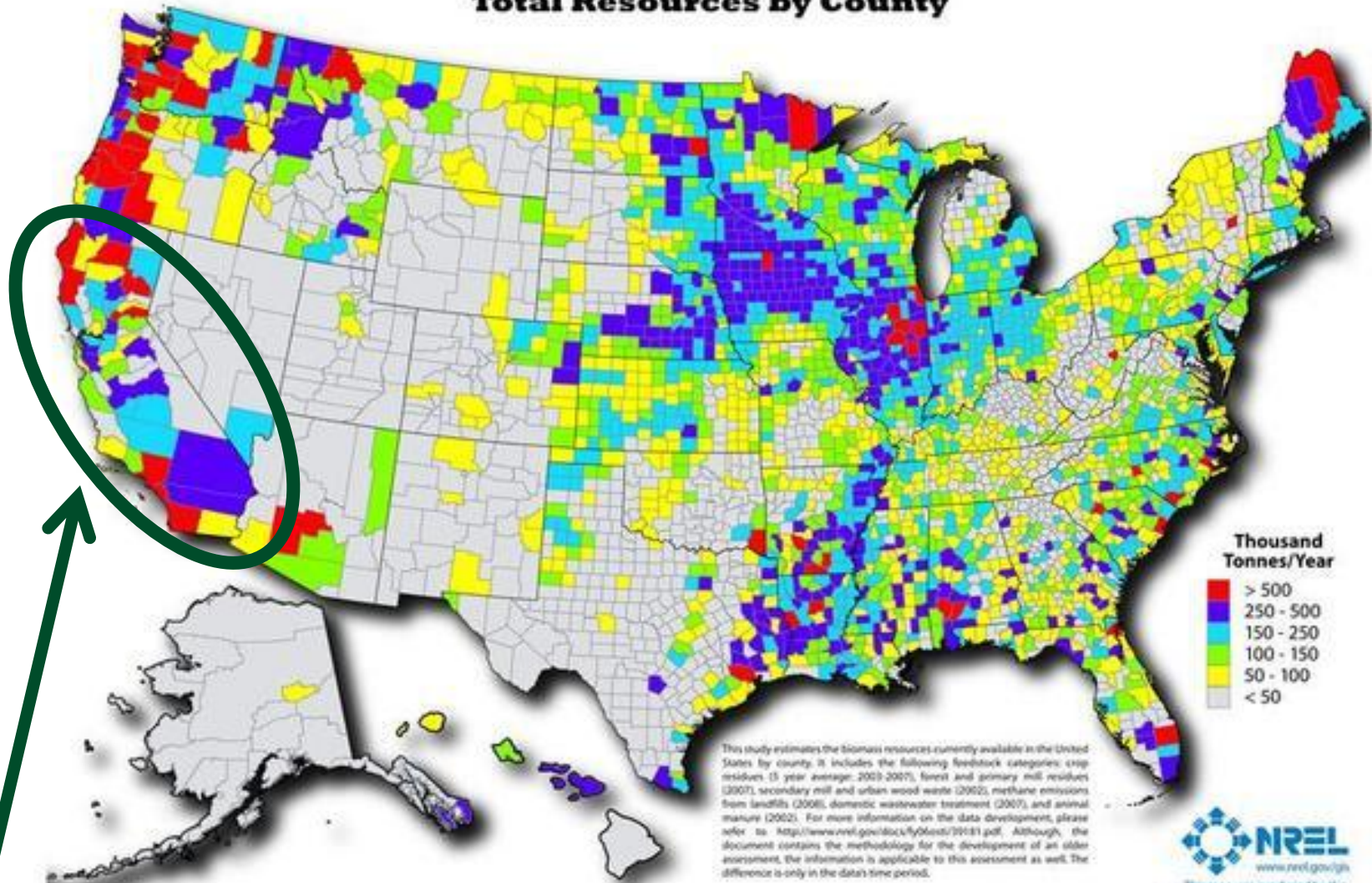
Chuck White

Director of Regulatory Affairs/West

Waste Management



Biomass Resources of the United States Total Resources by County

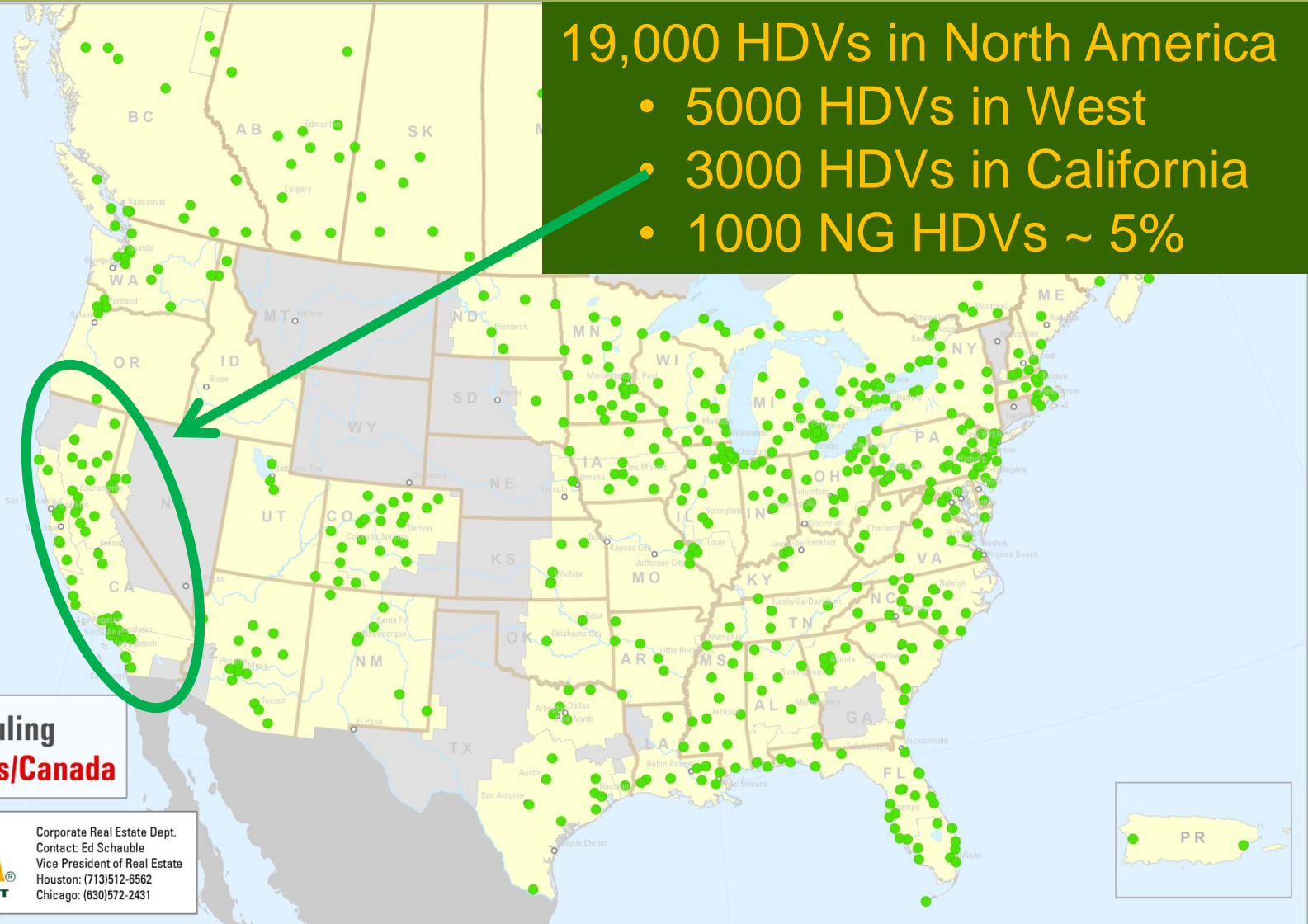


CEC BioEnergy Plan (2011): 2020 Potential = 44,300 GWh = 1.37 bgge
Agriculture = 23%; Forestry = 47%; MSW = 30%; Crops = 13%; Existing Use = 13%

367 WM Hauling Districts in North America

19,000 HDVs in North America

- 5000 HDVs in West
- 3000 HDVs in California
- 1000 NG HDVs ~ 5%



Legend

● Hauling

WM Hauling
United States/Canada

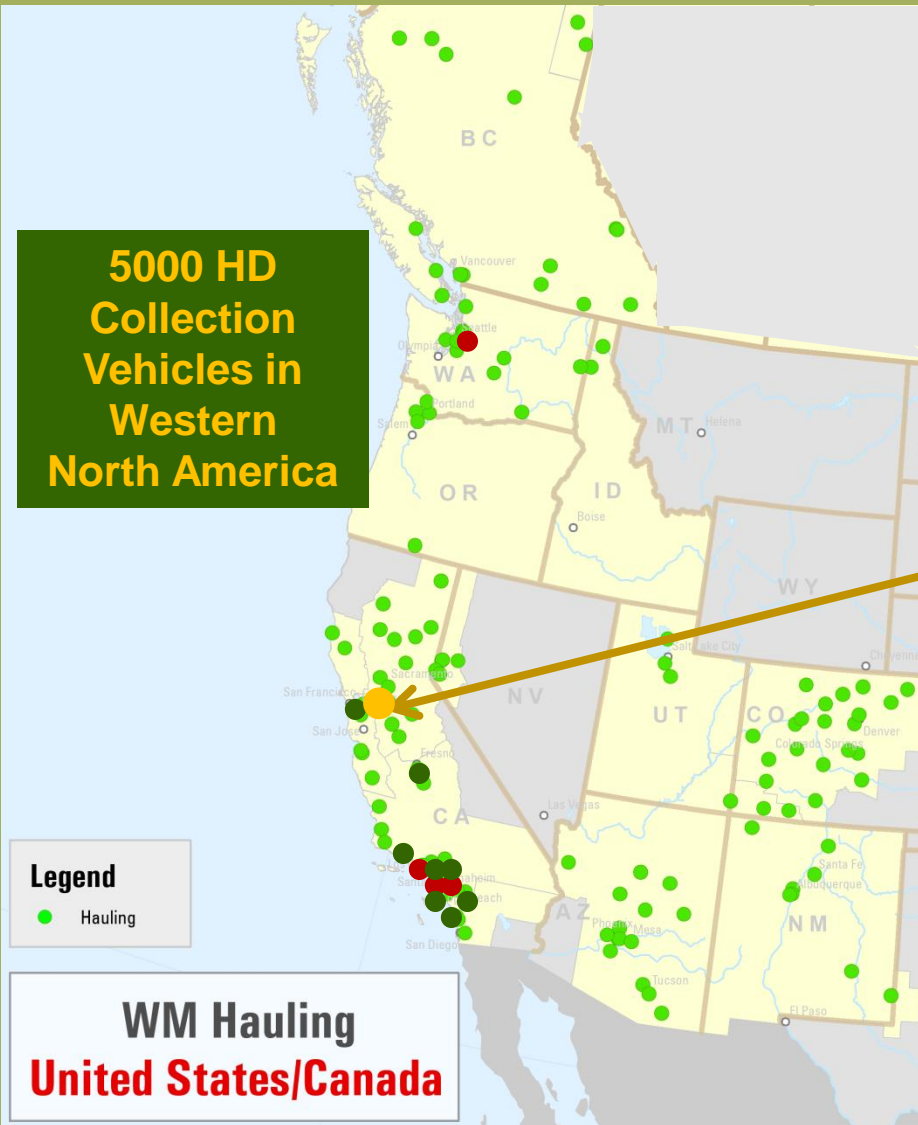


Corporate Real Estate Dept.
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WM West Group Hauling Districts

5000 HD
Collection
Vehicles in
Western
North America



- 5 CNG Facilities
(10 in construction process)
 - 500 Trucks
- 9 Bio/LNG Facilities
(2 are LCNG)
 - 500 Trucks
- Altamont Renewable LNG Facility
 - 13,000 Gal/day of RLNG
- 5 LCNG Facilities in development

WM's CA Natural Gas Fleet (31% and growing!)

WM's California Truck Fleet:

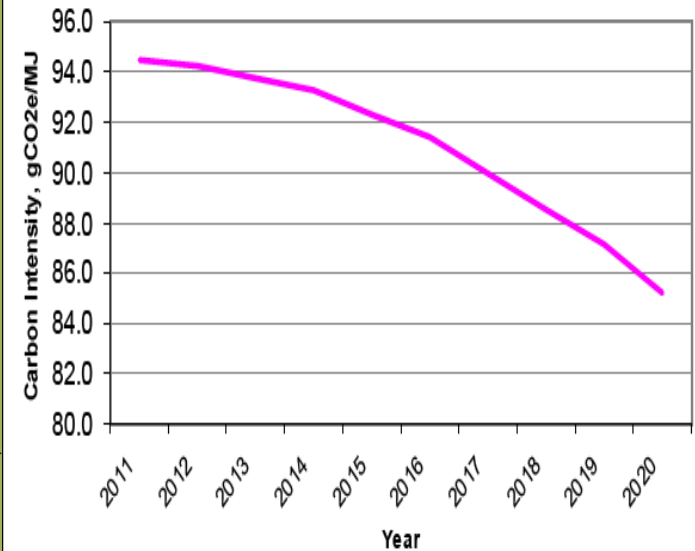
- *Diesel – 2200*
- *LNG/CNG – 1000*
- *Total -- 3200*



Drivers for Transportation Change

- Air District Clean Fleet Regulations
- Federal Renewable Fuel Standard
 - Tradable RINs
- CA C&T Regulations Adopted
 - Higher Costs for Fossil Fuels
 - Potential Revenues for Renewables
- Low Carbon Fuel Standard →
 - Started January, 2011.
 - 10% reduction in fuel carbon intensity by 2020
 - Demand for Efficiency and Renewable Fuels
- AB 118: Transition Funding Available
 - ~\$100 million/year for renewable fuels/vehicles

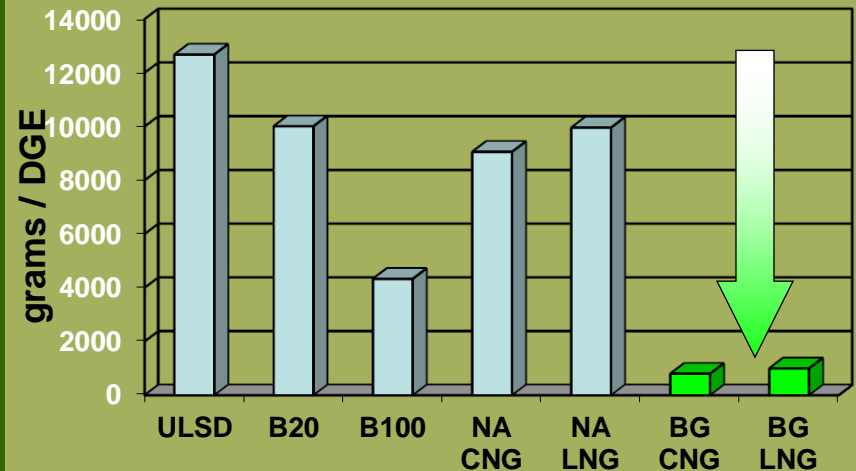
Compliance Schedule from 2011 to 2020 for Diesel Fuel or Diesel Fuel Substitutes



Gee . . . Where Can We Find BioGas ?

- It's available from
 - landfills
 - anaerobic digestion of animal, food, sewage, & crop waste
- Upgraded to hi-purity hi-BTU bio-methane (& other fuels)
- Very low greenhouse gas emissions
- Can displace 10 billion GGE per year (DOE estimate)
 - GHG emission reductions equal to taking 90 million light-duty vehicles off the road

WTW GHG Emissions



Landfill Gas: The Low Hanging Fruit

- Landfill Anaerobic Decomposition of Organic Waste = Biogenic Gas
- Gas is about 1/2 METHANE and 1/2 CARBON DIOXIDE
- Nitrogen and Oxygen introduced by air intrusion + additional impurities (NMOCs)
- 450 to 550 BTU per cubic foot of landfill gas
 - Medium BTU gas

Landfill Gas Collection System



LFG to LNG

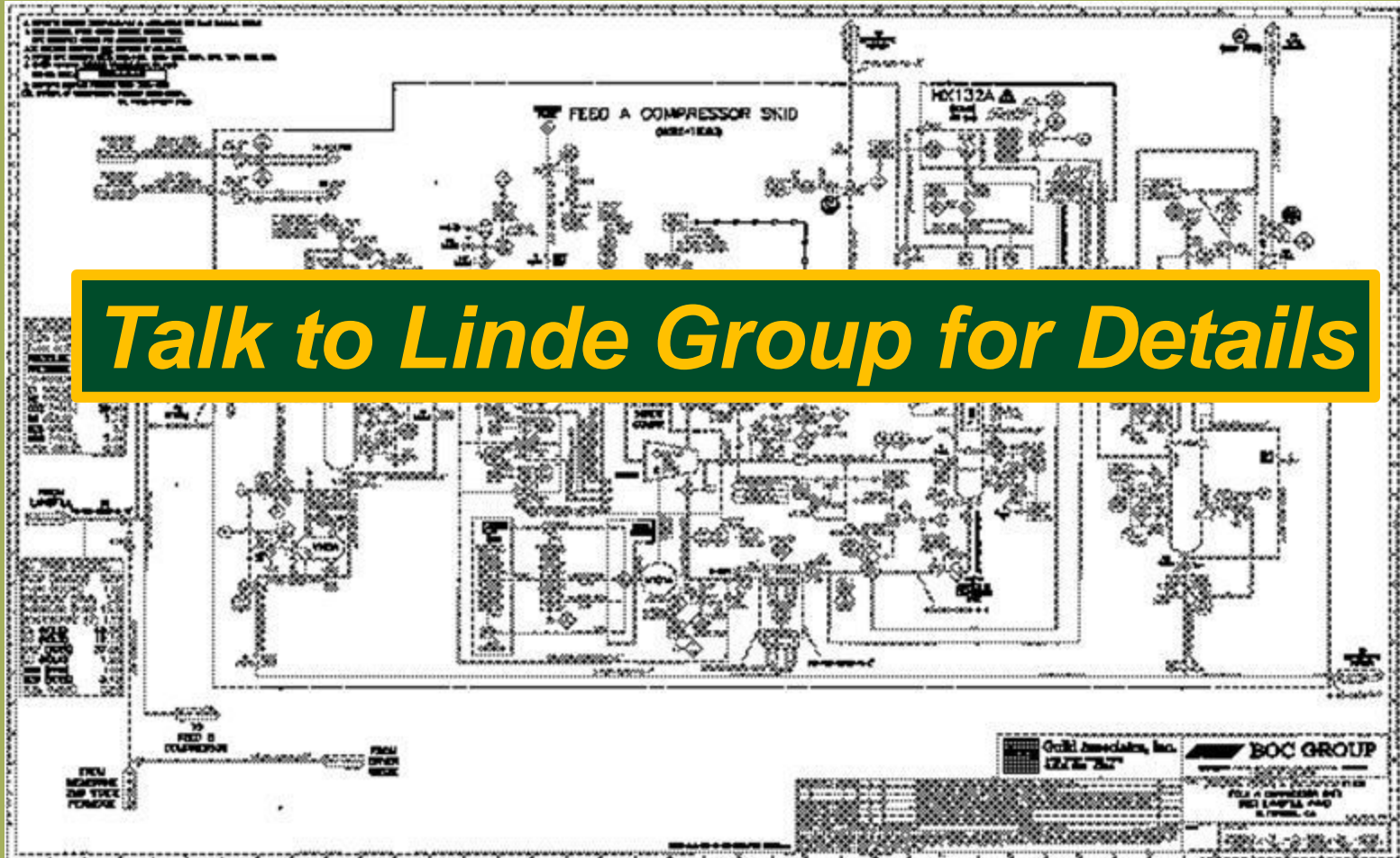


- Recovery and Utilization of Biomethane Landfill Gas for Transportation Fuel
- Altamont Landfill & Recycling Center, Fall 2009
- \$15.5 million capital investment
- 13,000 Bio-LNG Gallons/day
- Low Carbon Fuel” – lowest in CA
 - 5% carbon intensity of diesel
- Largest effort to introduce onsite liquefaction for landfill gas recovery in North America
- Utilize biogas resources and displace fossil fuels
- 2nd Plant being considered for SoCal

**\$2 million government funding
-CIWMB, CARB, CEC, SCAQMD**



Process & Instrument Diagram



Talk to Linde Group for Details

Bottom Line: It's Complicated & Expensive

Challenges And Solutions

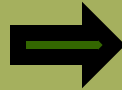
- **Aligning multiple unit operations**

- Going from ~50% CH₄ → >96%+ CH₄

- **Reducing CO₂ from ~50% to < 50 ppm**

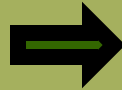
- **Variable NMOC species and amounts**

- **Efficiently liquefying NG on a small scale**

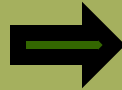


Robust design and plans

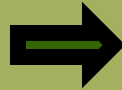
- Sulfur treat
- Membrane Separation
- Molecular Sieve



Polishing using Molecular Gate adsorbent



Multi-stage design



Gas Technology Institute design and heat exchanger developments



The High Mountain Fuels Partners



**Bio-
methane
Production**

**LNG
Production
and On-site
Storage**

**Logistics/
Distribution**

Fueling

**LNG
Consumption**



THE LINDE GROUP

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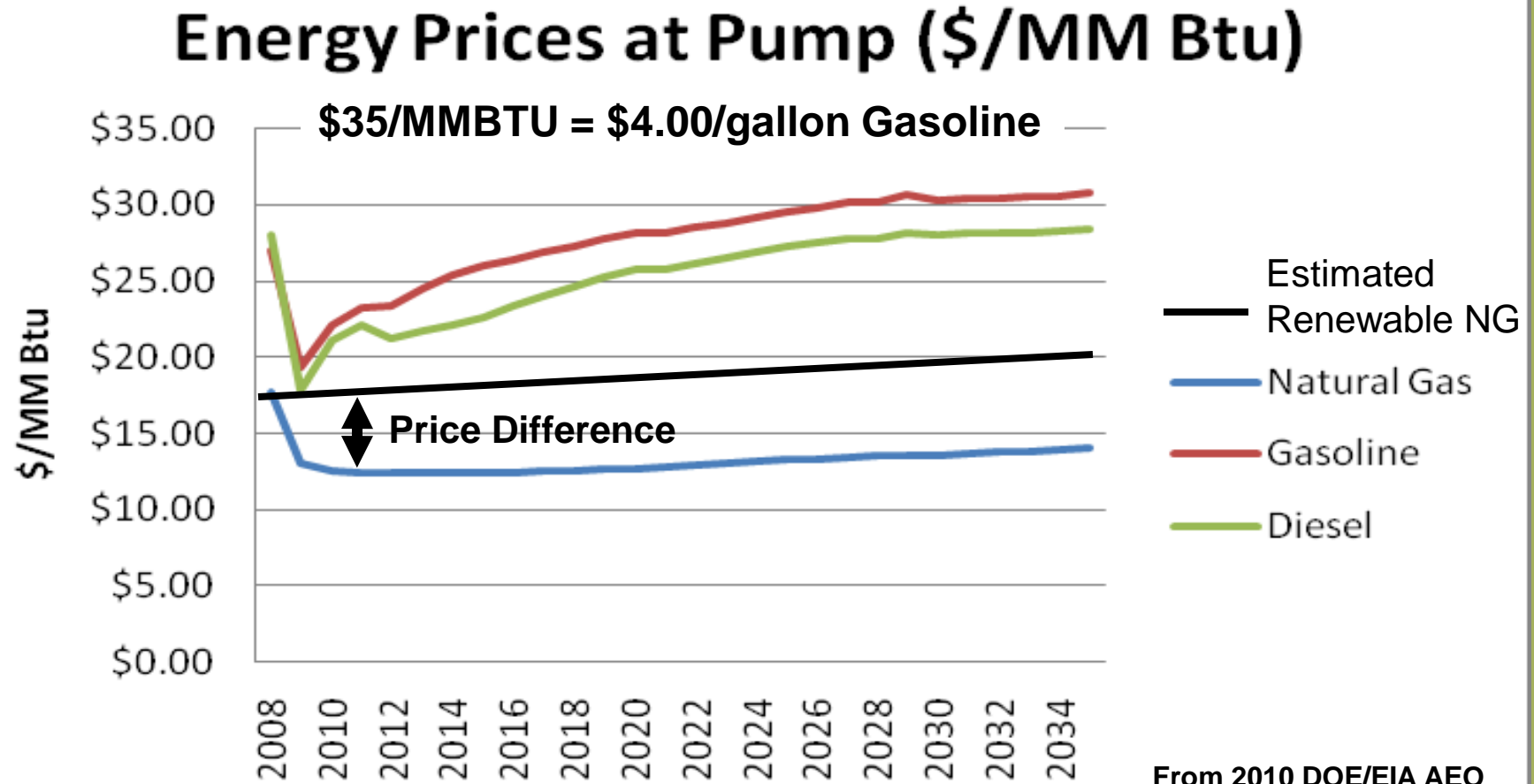


Comparison of LCFS Fuel Carbon Intensities (gCO₂e/MJ)

Fuel Type	Direct WTW Emissions	Indirect Emissions	Total Emissions	% of Diesel
Gasoline (CARBOB)	95.86	0	95.86	101
Diesel (ULSD)	94.71	0	94.71	100
Ethanol (Midwest WetMill Coal)	90.99	30	120.99	128
Ethanol (Dry Mill Proprietary)	43.20	30	73.20	77
Ethanol (Brazilian Sugarcane)	12.40	46	58.40	62
Biodiesel (Midwest Soybeans)	21.25	62	83.25	88
<u>Biodiesel (Waste Cooking Oils)</u>	<u>15.84</u>	<u>0</u>	<u>15.84</u>	<u>17</u>
<u>Biodiesel (Waste Corn Oil)</u>	<u>5.90</u>	<u>0</u>	<u>5.90</u>	<u>6</u>
<u>Renew-Diesel (Waste Tallow)</u>	<u>19.65</u>	<u>0</u>	<u>19.65</u>	<u>21</u>
CNG (NA Fossil, CA Compressed)	68.00	0	68.00	72
<u>Renewable CNG (Landfill)</u>	<u>11.26*</u>	<u>0</u>	<u>11.26*</u>	<u>13*</u>
<u>Renewable LNG (Landfill)</u>	<u>15.56*</u>	<u>0</u>	<u>15.56*</u>	<u>16*</u>

* Assumes use of Grid Power, Not Site Power. Use of Onsite LFG Power should lower CI by additional ~10%

Fossil Fuel Prices: Opportunity or Challenge?



Note: Estimates for approximate example only.
Does not reflect high petroleum price scenario.

Biomethane Vehicle Fuel: Barriers to Market

- **Efficient Vehicle Fueling with RNG:**
 - high BTU gas and pipeline distribution
- **RNG production and fleet fueling sites rarely co-located**
- **Barriers to RNG Vehicle Fuel Use:**
 - Pipeline connection fees, tariffs & specifications discourage RNG pipeline injection (estimated costs: \$1.8-\$2.5 million)
 - California bans LFG to Pipeline
 - Incentive programs favor power generation projects (ITC) over RNG pipeline injection
 - Market for vehicle fuel incentives (LCFS and RFS II) are uncertain, illiquid and are not “financeable”



The California Landfill Gas to Pipeline Problem

- Landfill Gas is the Low-Hanging Fruit
 - Plenty of it and currently under utilized
 - SCAQMD Rule may stop LFGTE engines
- 1988 Hayden Legislation (H&SC 25420-21)
 - No VC above CPUC standard (1170 ppb)
 - Twice monthly sampling of LFG for VC
 - \$2500/day fine if exceeds: *both* LFG producer & pipeline owner
- VC Source: Chlorinated Solvents (e.g., Oil, HW co-disposal), but . . .
 - Banned from SW landfills in California for over 30 years
 - 1999 SCS Study of raw landfill gas in SCAQMD
 - 209 samples collected at 27 SoCal landfills
 - Average concentration of untreated LFG: 1800 ppb
- Current CPUC Tariffs: No LFG in pipelines
 - All three pipeline IOUs: SoCalGas, SDG&E, PG&E



Treated Landfill Gas to Pipeline: Next Steps

Gas Technology Institute (GTI)

- Not-for-profit R&D Organization
 - Leader in Gas Technology Development and Deployment
- GTI published its December 31, 2009 Report : Pipeline Quality Biogas: Guidance Document for Dairy Waste, Wastewater Treatment Sludge and Landfill Conversion
 - Tested 3 landfill gas-to-pipeline quality gas projects
 - Vinyl Chloride well below 1000 ppb (CPUC level is 1070 ppb)
- Ongoing GTI Study: Pipeline Quality Renewable Natural Gas: Guidance Document for Landfill Derived RNG into Existing Natural Gas Networks
 - SWANA High BTU Gas Group and WM supporting this study
 - Completion Anticipated by early 2012
 - Technologies for Treatment and Monitoring of LFG to Pipeline



Keys to Development of RNG for Vehicles

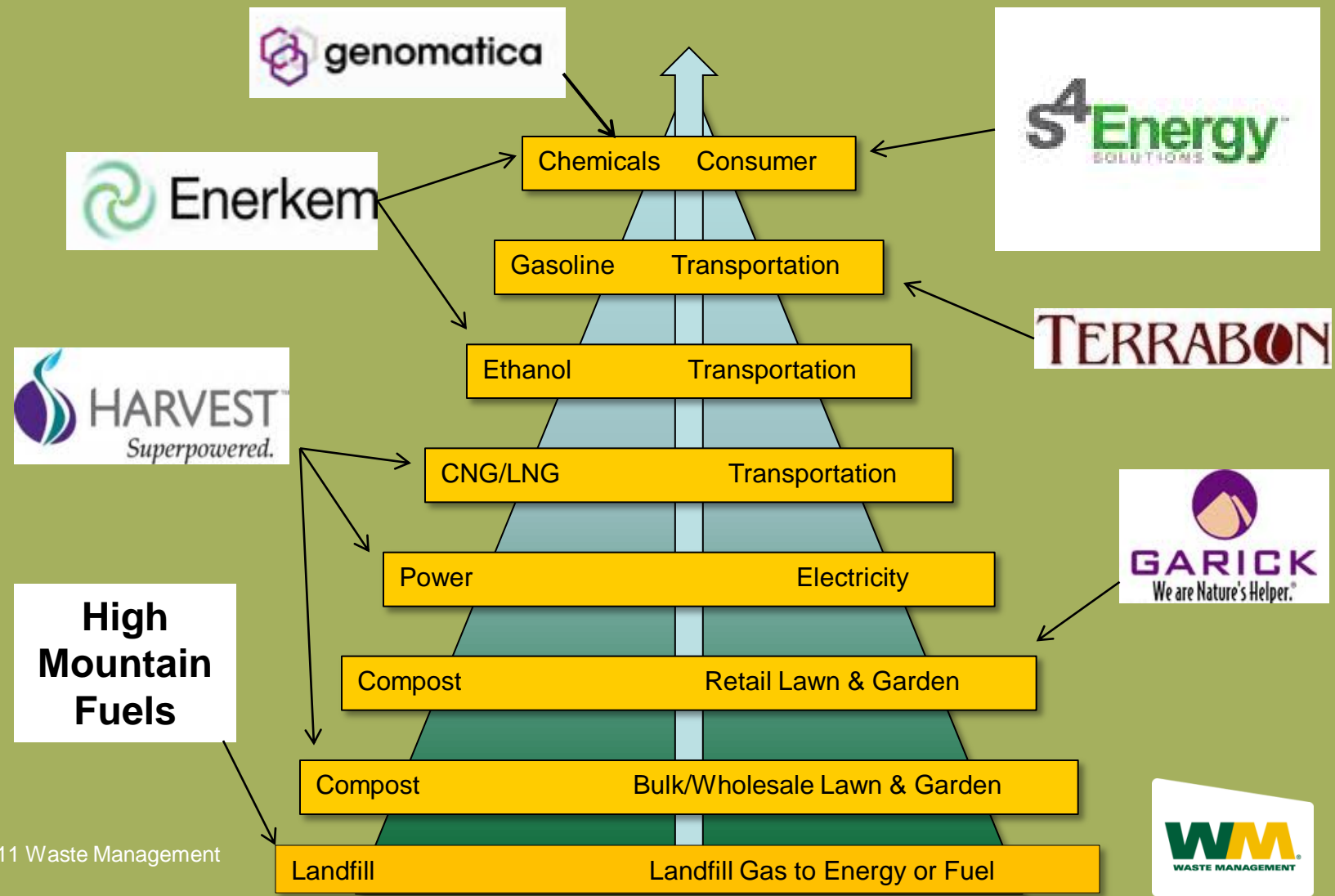
1. Ensure open access to pipelines and transportation on grid at reasonable cost
2. Improve stability and liquidity of vehicle fuel credit markets
3. Level playing field by providing comparable tax incentives for RNG pipeline projects as are available in biogas power generation market
4. Develop natural gas vehicle market by incentivizing natural gas vehicle purchase, use & fueling infrastructure (e.g., AB 118)



Emerging Organics Technologies



Potential Increasing Value



In Summary . . .

- BioGas Resources are Readily Available
 - landfills & waste materials
- Waste Derived Fuels have Lowest GHGs
- Renewable LNG/CNG is cheaper than diesel
 - but more expensive than fossil NG
- RFS-2 and Low Carbon Fuel Standards
 - Can provide supplemental revenue to bridge the gap
- What's Needed?
 - Provide incentive programs (AB 118, RFS, LCFS, Tax Credits)
 - Maintain Predictability & Stability
 - Access to Efficient Pipeline Distribution of RNG



Any Questions?

