Renewable Energy from Waste Technologies and Projects

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Gershman, Brickner & Bratton, Inc.

Presented at the West Coast Conversion Congress
December 3, 2013

GBB -- Quality – Value – Ethics – Results

• Established in 1980
• Solid Waste Management and Technology Consultants
• Helping Clients Turn Problems into Opportunities
GBB Waste Technology Services

- Economic, technical, and environmental reviews
- Markets development
- Process planning and design
- Waste characterization and sourcing
- Procurement and negotiation assistance
- Independent feasibility consultant
- Technology due diligence
- Acceptance testing and operations monitoring

www.rewmag.com
Outline

MSW Management in the US
Renewable Energy form Waste Technologies
Mechanical Biological Treatment-MBT
Trends, Expectations, and Opportunities for the Future

SOLID WASTE MANAGEMENT IN THE U.S.
EPA Significant Changes to the Waste Management Policy, 2005

EPA Waste Hierarchies

**Waste Management Hierarchy**
- Source Reduction & Reuse
- Recycling / Composting
- Energy Recovery
- Treatment & Disposal

**Food Recovery Hierarchy**
- Source Reduction
- Food Hungry People
- Feed Animals
- Industrial Uses
- Composting
- Incineration or Landfill

MSW Disposition in the U.S.

**EPA Estimate:**
- 250 million tons (2011)
- Discarded 53.60%
- Recovery 24.70%
- Combustion with Energy Recovery 11.70%

**Biocycle Estimate:**
- 389 million tons (2008)
- Discarded 69.30%
- Recovery 24.10%
- Combustion with Energy Recovery 6.70%
### MSW Composition

**Total MSW generation, 2010** (by material before recycling)

- Paper & Paperboard: 29%
- Food Scraps: 14%
- Yard Trimnings: 13%
- Plastics: 12%
- Metals: 9%
- Rubber & Leather: 8%
- Wood: 6%
- Glass: 5%
- Other: 4%

**MSW going to landfills, 2010** (by material after recycling)

- Paper & Paperboard: 21%
- Food Scraps: 21%
- Yard Trimnings: 17%
- Plastics: 17%
- Metals: 9%
- Rubber & Leather: 9%
- Textiles: 8%
- Wood: 8%
- Glass: 5%
- Other: 4%

### 2008 - California Landfills 40 Million Tons

**California AB 341**

- Set a goal of achieving a 75% recycling rate by 2020
- CalRecycle estimates another 22 million tons per year will be diverted from landfills
- More difficult materials left to divert
- New and innovative systems will be needed

**Top 10 CA landfilled materials**

<table>
<thead>
<tr>
<th>Material type</th>
<th>Percent</th>
<th>CA TPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>15.5%</td>
<td>6,158,120</td>
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<tr>
<td>Lumber</td>
<td>14.5%</td>
<td>5,765,482</td>
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<tr>
<td>Composite inerts</td>
<td>5.5%</td>
<td>2,175,322</td>
</tr>
<tr>
<td>Composite paper</td>
<td>5.2%</td>
<td>2,056,546</td>
</tr>
<tr>
<td>Uncoated Cardboard</td>
<td>4.8%</td>
<td>1,905,897</td>
</tr>
<tr>
<td>Composite Organic</td>
<td>4.3%</td>
<td>1,719743</td>
</tr>
<tr>
<td>Leaves and grass</td>
<td>3.8%</td>
<td>1,512,832</td>
</tr>
<tr>
<td>Bulky Items</td>
<td>3.5%</td>
<td>1,393,091</td>
</tr>
<tr>
<td>Carpet</td>
<td>3.2%</td>
<td>1,285,473</td>
</tr>
<tr>
<td>Rock, soil, fines</td>
<td>3.2%</td>
<td>1,259,308</td>
</tr>
</tbody>
</table>

*Source: CalRecycle 2008 Statewide Waste Characterization Study*
U.S. Waste Management Infrastructure

<table>
<thead>
<tr>
<th>Technology</th>
<th>Operating Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Recovery Facilities (MRF)</td>
<td>586</td>
</tr>
<tr>
<td>Composting</td>
<td>2,300</td>
</tr>
<tr>
<td>Mixed Waste Processing Facilities (MWPF)</td>
<td>51</td>
</tr>
<tr>
<td>Mass Burn WTE</td>
<td>65</td>
</tr>
<tr>
<td>Modular WTE</td>
<td>9</td>
</tr>
<tr>
<td>RDF -Processing &amp;/or Combustion</td>
<td>20</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>19</td>
</tr>
<tr>
<td>Transfer Stations</td>
<td>No data</td>
</tr>
<tr>
<td>Landfills</td>
<td>1,908</td>
</tr>
</tbody>
</table>

Cost of Collection and Disposal

- Costs and revenues affected by:
  - Community size
  - Government structure
  - Facilities used
  - Waste supply agreements
  - Revenue sharing back to customer
  - Open vs. closed market services
  - Politics
- Collection
  - Residential solid waste: $10 - $40 USD$ per month per household
  - Residential recycling $2 - $4 per month per household
- Commercial waste
  - Charged on a per month per box basis, and may include a separate pass-through cost for disposal charges
  - 2 cubic yard box serviced once per week = $60 - $140 per month
  - 6 cubic yard box serviced once per week = $130 - $280 per month
- WTE tipping fee = $68/ton (2010)
- Landfill tipping fee = $45/ton (2012)
Collection Needs to Match Up with Technologies

- *One bin – two bin – three bin - four?*
- *Which shall it be to be greener evermore?*

California communities are changing their collection practices to further recycling

**Residential Systems**
- 1 Bin for All, like Newport Beach
- 3-cart system, like San Francisco
- 1+1+1: Weekly recycling and composting, EDW trash, like in Portland, OR
- Dual pass 2-cart system, like Long Beach

**Commercial Systems**
- Open market, most
- 2-stream “wet/dry” system, like San Jose
- City forces conduct collection, like Santa Monica
- Closed market, like San Francisco
Increased Interest in Renewable Energy from Waste Technologies

Contributing factors:
• Renewable energy policy
• Greater revenue potential
• Funding (grants/loans)
• Local governments desire to be greener
• GHG considerations
• Landfill waste diversion goals
• Local jobs
• Increasing collection/disposal fees

>579 Technology and/or Project Development Companies Worldwide

150 Commercial or Demonstration Facilities with MSW Worldwide
Mass Burn
Waste-to-Energy Facilities

North Broward County, FL - Wheelabrator
Alexandria/Arlington, VA - Covanta
Springfield, MA - Covanta
Baltimore, MD - Wheelabrator

US has long-time RDF facility survivors with >20 years of operations, including RDF/Dedicated Boiler Facilities

Rochester, MA
Hartford, CT
West Palm Beach, FL
La Crosse, WI
California Waste to Energy Facilities

**Covanta Stanislaus**
- Modesto, CA, began operation in 1989
- 800 TPD
- 22.5 MW sold to Pacific Gas and Electric

**Southeast Resource Recovery**
- Long Beach, CA, began operation in 1988
- Owned by City of Long Beach and LA County Sanitation District and operated by Covanta
- 1,380 TPD
- 36 MW sold to Southern CA Edison

**Commerce Refuse-to-Energy**
- Commerce City, CA, began operation in 1987
- Owned/operated by Los Angeles County Sanitation District
- 360 TPD
- 10 MW sold to Southern California Edison

Energy Recovery and Recycling in the Pacific Northwest

**Burnaby, B.C. (Greater Vancouver Regional District)**
- 850 TPD since 1988
- 25 MW power
- 55 % recycling

**Marion County, OR**
- 550 TPD since 1987
- 13 MW power
- 56.5 % recycling

**City of Spokane, WA**
- 800 TPD since 1991
- 26 MW power
- 47 % recycling
Locations Advancing WTE Technologies

- Mass burn WTE expansions completed
  - Hillsborough County, FL - Covanta
  - Lee County, FL - Covanta
  - Olmsted County, MN – Olmsted County
  - Honolulu, HI – Covanta
- Mass burn WTE facilities under construction
  - Durham York (Ontario CN) - Covanta
  - Palm Beach County, FL (SWAPBC) – B&W
- Advancing new facilities
  - Allentown, PA – Delta Thermo Energy Inc.
  - Baltimore, MD – Energy Answers
  - City of Cleveland, OH – to be determined
  - City of Houston, TX – to be determined
  - City of Los Angeles, CA – Green Conversion Systems
  - County of Maui, HI - Anaergia
  - Frederick County, MD (NMWDA) - Wheelabrator
  - Iowa City, IO – to be determined
  - Metro Vancouver, CN – to be determined
  - Puerto Rico – Energy Answers
  - Region of Peel, Ontario, CN - Covanta

Solid Waste Authority of Palm Beach County, FL

- New Facility - Notice of Award, April 2011
  - 3,000 TPD Mass Burn facility
  - 130 MW renewable power; enough for over 86,000 houses
  - $668 million construction price
  - $20.5 million first year O&M cost
  - To use advanced emissions control system
- Groundbreaking - April 2012
- Expected commercial operation 2015

Source: Babcock & Wilcox; artist’s rendering of proposed facility.
**WTE Emission Reductions for New Facility**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Current CA WTE Permit (SERRF)</th>
<th>USEPA MACT</th>
<th>Palm Beach County, FL WTE Permit (under construction)</th>
<th>City of Los Angeles Green Conversion Systems</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Nitrogen oxides</td>
<td>180</td>
<td>150</td>
<td>50</td>
<td>5</td>
<td>PPMV</td>
</tr>
<tr>
<td>Sulfur oxides</td>
<td>29</td>
<td>30</td>
<td>24</td>
<td>10 mg/DCSM</td>
<td>PPMV</td>
</tr>
<tr>
<td>Particulate Matters</td>
<td>27</td>
<td>20</td>
<td>12</td>
<td>1.4</td>
<td>mg/DCSM</td>
</tr>
<tr>
<td>Dioxin/Furan</td>
<td>30</td>
<td>13</td>
<td>10</td>
<td>0.014</td>
<td>Ng/DCSM</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.04</td>
<td>0.0026</td>
<td>0.01</td>
<td>0.35 Ng/DCSM</td>
<td>mg/DCSM</td>
</tr>
<tr>
<td>Lead</td>
<td>0.44</td>
<td>0.14</td>
<td>0.125</td>
<td>0.004</td>
<td>mg/DCSM</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.08</td>
<td>0.05</td>
<td>0.025</td>
<td>0.003</td>
<td>mg/DCSM</td>
</tr>
<tr>
<td>Hydrogen Chloride</td>
<td>29</td>
<td>25</td>
<td>20</td>
<td>2.5 mg/DCSM</td>
<td>PPMV</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>25 mg/DCSM</td>
<td>PPMV</td>
</tr>
</tbody>
</table>

**Renewable Energy Technology Land Use**

Waste-to-Energy uses less land per megawatt than other renewable energy sources

- □ WTE facilities require an average of 0.7 acres/MW
- □ Landfill gas requires 27 acres/MW
- □ Solar requires 8 acres/MW
- □ Wind requires 18 acres/MW

Source: Covanta Energy, 2012
Conversion Technologies and Products

Feedstock

*may be pre-processed

Conversion Technology
- Pyrolysis
- Gasification
- Combustion
- Anaerobic Digestion
- Ethanol Fermentation
- Aerobic Composting

Primary Product
- Char
- Tars & Oils
- Syngas
- Heat
- Biogas
- Ethanol
- Compost

Product Conversion
- Extraction
- Upgrading
- Synthesis
- Engine
- Gas Turbine
- Boiler

Secondary Product
- Chemicals
- Gasoline
- Ethanol/Methanol
- Ammonia
- Electricity

Gasification/Fermentation

- Partial combustion in an air-controlled environment
- With fermentation, includes enzymatic digestion
- Product: Syngas for production of electricity, chemicals/fuels (ethanol)
- Feedstocks: biomass, medical waste, demonstration-scale MSW
- Plasma gasification: a plasma arc is used as a heat source
Pyrolysis

• Thermal conversion in the absence of oxygen
• Non-recyclable plastics to oils, fuels

Anaerobic Digestion

Biological degradation of organic material in absence of oxygen

• Biogas fuel for electricity and/or heat production; can be conditioned to pipeline quality
• Digestate for soil amendment, animal bedding, or rolled into a composting process

There are 13 AD plants accepting food waste in the U.S., including demonstration, pilot and commercial projects

Renewable Waste Intelligence, March 2013
Companies in U.S. at Work with AD

Locations Advancing Conversion Technologies

- Advancing new facilities with thermal technologies:
  - City of Taunton, MA – Interstate Waste Technologies, Inc.
  - Three Rivers Solid Waste Management Authority – Pontotoc, MS – Enerkem
- Anaerobic digestion specific RFPs issued:
  - Humboldt Waste Management Authority, Eureka, CA
  - Montgomery, AL - under construction w/Zero Waste Energy
- Anaerobic Digestion plants under development:
  - City of Newport News, VA - quasar
  - Town of Bourne, MA - Harvest Power
  - Town of Brunswick, ME - quasar and Village Green Ventures
  - City of Columbia, SC - W2E
  - City of Portland, OR - Columbia Biogas
  - Monticello, IN - Waste No Energy LLC
  - City of Charlotte, NC - Blue Sphere
  - Perris, CA - CR&R
  - Santa Barbara, CA – Mustang Renewable Power Ventures
### Technology Commercialization Examples

<table>
<thead>
<tr>
<th>Location</th>
<th>Edmonton, Alberta, CA</th>
<th>Vero Beach, FL</th>
<th>Storey, NV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Gasification/ Catal.Conv. of Syngas</td>
<td>Gasification/ Ferment. of Syngas</td>
<td>Gasification/ Catalytic Conv. of Syngas</td>
</tr>
<tr>
<td>Developer</td>
<td>Enerkem</td>
<td>INEOS Bio</td>
<td>Fulcrum Bioenergy</td>
</tr>
<tr>
<td>Feedstock</td>
<td>Non-recycled MSW</td>
<td>Yard, vegetative, residential waste</td>
<td>Post-sorted MSW</td>
</tr>
<tr>
<td>Throughput (TPD)</td>
<td>300</td>
<td>450</td>
<td>400</td>
</tr>
<tr>
<td>Energy Products</td>
<td>Methanol; Ethanol</td>
<td>Ethanol</td>
<td>Ethanol; Propanol</td>
</tr>
<tr>
<td>Cost</td>
<td>$80M</td>
<td>$130M</td>
<td>$120M</td>
</tr>
<tr>
<td>Federal Grants/Loan Guarantees</td>
<td>$23.5M</td>
<td>$125M</td>
<td>--</td>
</tr>
<tr>
<td>Start Date</td>
<td>2014</td>
<td>June 2012</td>
<td>2015</td>
</tr>
</tbody>
</table>

### Technology Commercialization Examples

<table>
<thead>
<tr>
<th>Location</th>
<th>Monterey, CA</th>
<th>San Diego, CA</th>
<th>South San Francisco, CA</th>
<th>Sacramento, CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Anaerobic Digestion</td>
<td>Anaerobic Digestion</td>
<td>Clean World Partners</td>
<td></td>
</tr>
<tr>
<td>Developer</td>
<td>Zero Waste Energy</td>
<td>Clean World Partners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedstock</td>
<td>SSO (food and yard waste)</td>
<td>Commercial food waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughput (TPY)</td>
<td>~5,000</td>
<td>90,000</td>
<td>11,200</td>
<td>100</td>
</tr>
<tr>
<td>Energy Products</td>
<td>Biogas; Electricity</td>
<td>Electricity</td>
<td>CNG, Compost</td>
<td>Biogas; Electricity</td>
</tr>
<tr>
<td>Cost</td>
<td>$1.6M</td>
<td>$11.8M</td>
<td>-</td>
<td>$12M</td>
</tr>
<tr>
<td>Federal Grants/Loan Guarantees</td>
<td>--</td>
<td></td>
<td>$1.8M</td>
<td></td>
</tr>
<tr>
<td>Start Date</td>
<td>Jan 2013</td>
<td>Fall 2013</td>
<td>Q2 2014</td>
<td>2014</td>
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</table>
Mechanical Biological Treatment (MBT)

- Originated in Germany in 1999 (now 36 operating MBTs)
- 330 plants in EU most of them in: Germany, Austria, Italy, Switzerland and the Netherlands, while UK is catching up
- MBT scope:
  - Mechanical Sorting of recyclables and organics
  - Food scraps and green waste are processed through anaerobic digestion and composting units
  - Dry materials into a high BTU fuel fraction as RDF
- RDF key: 54% to dedicated boilers, 16% to coal plants, 11% to cement kilns and 19% to other users

Source: Mechanical Biological Treatment of Municipal Solid Waste. UK Department for Environment Food & Rural Affairs (DEFRA). February 2013
German Integrated Waste Management System

- 0.4% of waste to landfills
- 81% of household waste to MBT Plants

Facilities Tour – June 14, 2013

- Waste Management Centre - Pohlsche Heide
  - MBT with partial flow anaerobic dry digestion and composting and tunnel anaerobic dry digestion plant for organic waste
  - See: http://www.pohlsche-heide.de/english/index.php?head=home&nav=company&um=home&content=company
  - Demonstration site for CReED

- Small sized industrial RDF combined heat and power (CHP) plant - Minden
Hannover Energy from Waste Facility...
on the Way to the Airport

...where the rest of the waste goes!!

TRENDS, EXPECTATIONS, AND OPPORTUNITIES
FOR THE FUTURE
What is coming to America for the 60% Going to Landfills?

- Organics treated as recyclables
  - Co-composting and anaerobic digestion ready for prime time
- Engineered fuels (EF) to non-renewable fuels
  - Sourced from MSW and industrial waste streams
- MBT
- Conversion technologies for higher valued liquid fuels and chemicals
  - MSW -- watch what is coming on line closely
  - Mixed plastics – almost ready for prime time
- Proven WTE; but depends on:
  - Energy economics
  - Political will

Project Building Blocks

- Regulatory impetus and incentives
- Limited or high disposal costs
- Waste Supply
- Markets
- Site with good logistics that can be permitted
- Landfill for ash and by-pass
- Contractor with resources and proven technology
- Capital
- Ability to pay service fees
- Financeability
- Compatibility with High Level of Recycling
- Political Will
Project Development

- Address the “building blocks” with resources
- Match collection with processing/recovery
- Decide on ownership and risk posture
- Select contractor and technology
  - Procurement process vs. developer “Valley of Death”
- Developing public knowledge and acknowledgement of need
- Have patience….these projects may take years to get to project financing

Engaging the Public

Fighting emotion and bias with logic and science

- Engage public relations support
- Conduct focus groups
- Be ready for anti-environmental terrorism

Solid Waste Authority of Palm Beach County response to the Florida Sierra Club

Legislation and Regulations

- Will more states ban food scraps from disposal?
- Will U.S. landfill disposal ever be as expensive as in EU and UK?
- Permitting needs to be streamlined/rational
- Several states stepping up recycling/diversion goals and Producer Responsibility (EPR)
- EPA needs to help lead the way with RFS and EF rules

- Waste is very recyclable and it is also very renewable!

Examples of State Regulatory Initiatives

State goals to drive action:
- CA - 75% of MSW & 50% organic waste by 2020
- WA - 50% recycling met in 2011; eliminate yard waste from landfills by 2012;
- OR - 50% recovery goal met in 2010; Material Management 2050 Vision;

States with bans on food waste from commercial generators:
- MA 2014
- VT 2014 (large generators); 2020 (all generators)
- CT 2014 (large generators); 2020 (all generators)
Merging Waste Management and Climate Change Policies in California

- CARB & CalRecycle formed a joint task force to coordinate solid waste and climate change initiatives
- Waste Management Sector Implementation Plan goals
  - 20-30 MM TPY CO2e reduction by 2020
  - GHG emissions to net zero by 2035
- Energy recovery of non-recyclable waste seen as a viable greenhouse gas reduction tool

### Select California Waste Management Policies Under Consideration

<table>
<thead>
<tr>
<th>Category</th>
<th>Action</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding &amp; Incentives</td>
<td>Establish feed-in-tariffs for in-state renewable energy</td>
<td>2013-2020</td>
</tr>
<tr>
<td>Funding &amp; Incentives</td>
<td>Evaluate MSW thermal technologies to receive renewable energy credits</td>
<td>2014-2015</td>
</tr>
<tr>
<td>Funding &amp; Incentives</td>
<td>Obtain cap &amp; trade funding for compost and anaerobic digestion projects, recycling and remanufacturing facilities</td>
<td>2013-2020</td>
</tr>
<tr>
<td>Research</td>
<td>Research for safe and beneficial uses of MSW conversion ash</td>
<td>Through 2025</td>
</tr>
<tr>
<td>Cap and trade</td>
<td>Determine status of MSW thermal facilities in cap and trade</td>
<td>Late 2015</td>
</tr>
<tr>
<td>Cap and trade</td>
<td>Review landfills for inclusion in cap and trade</td>
<td>Late 2014</td>
</tr>
<tr>
<td>Regulatory / Statutory</td>
<td>Consider actions moving toward inert only landfilling practices</td>
<td>Through 2020</td>
</tr>
</tbody>
</table>

Source: September 17, 2013 Waste Management Sector Implementation Plan
Engineered Fuel for Significant Landfill Diversion in California

- In California, 139 “intermediate processing” facilities accept “aggregated materials” of some kind for “material recovery”
- Of the 139 facilities:
  - 56 (or 40%) process “mixed solid waste”
  - 54 (or 39%) process “mixed inerts/C&D”
- These facilities can be retrofitted to produce Engineered Fuel
- Use Engineered Fuel in:
  - Existing Cement Kilns
  - Existing Biomass and Coal Boilers
  - New Dedicated Boilers/WTE facilities permitted with MACT

<table>
<thead>
<tr>
<th>State</th>
<th>Recycled/Composted</th>
<th>WTE</th>
<th>Landfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>32,366,636</td>
<td>627,039</td>
<td>28,216,903</td>
</tr>
<tr>
<td>OR</td>
<td>1,761,727</td>
<td>181,666</td>
<td>2,689,119</td>
</tr>
<tr>
<td>WA</td>
<td>2,102,022</td>
<td>332,301</td>
<td>4,986,236</td>
</tr>
</tbody>
</table>

*BioCycle, published October 2010*
Recycling and Power or Fuel Production Potential from Landfilled Waste

- Additional recyclables recovered @ 10 percent of tons
- 1,000 TPD of MSW (340,000 TPY) = 20 MW
- 1 Ton of MSW = 60 gallons ethanol

<table>
<thead>
<tr>
<th>State</th>
<th>Landfilled (Tons)</th>
<th>Materials Recovery (Tons)</th>
<th>Electricity (MW) or Ethanol (MG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>28,216,903</td>
<td>2,821,690</td>
<td>1,660 or 1,693</td>
</tr>
<tr>
<td>OR</td>
<td>2,689,119</td>
<td>268,912</td>
<td>158 or 161</td>
</tr>
<tr>
<td>WA</td>
<td>4,986,236</td>
<td>498,624</td>
<td>293 or 299</td>
</tr>
</tbody>
</table>

A Realistic & Ultimate Goal:

- Fully Integrated and Efficient Waste Management System with Significant Diversion (Recycling) and WTE-WCT
- …in public–private partnerships!
- …for more jobs, better environment, and energy independence for America!
Questions and comments?

**Thank you!**

Harvey Gershman  
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