Southern States Energy Board
Coal Combustion Products and Rare Earth Elements
September 24, 2017
Coal Ash Opportunities In A Dynamic Market

• Regulatory Climate For CCPs
• Production & Use – Traditional Markets
• CCP/REE Trends & Market Drivers
• REE Opportunity Status
• Impacts To States & Policies
RCRA 1976 – Energy Goal & Objective

- **RCRA -42 U.S. Code § 6902 - Objectives and national policy**
- **Objective** “The objectives of this chapter are to promote the protection of health and the environment and to conserve valuable material and energy resources by”… “providing technical and financial assistance to State and local governments and interstate agencies for the development of solid waste management plans (including resource recovery and resource conservation systems) which will promote improved solid waste management techniques (including more effective organizational arrangements), new and improved methods of collection, separation, and recovery of solid waste, and the environmentally safe disposal of non-recoverable residues;”

- “The Congress finds with respect to materials, that …millions of tons of recoverable material which could be used are needlessly buried each year” and that “the recovery and conservation of such materials can reduce the dependence of the United States on foreign resources and reduce the deficit in its balance of payments.”
CCR Regulatory Backdrop

- EPA Issued RCRA Subtitle D Regulation – April 17, 2015
  - Focus On Disposal - Self Implementing – Citizen Suit Enforcement
  - Primary Purpose – Regulate CCR Disposal – Landfills & Ponds
    - Next Major Impact Related To Groundwater Deadlines – October 2017
  - CCR Rules Impact CCP Utilization As Resource
    - EPA Introduced New Concept & Terminology- Encapsulated

- Water Infrastructure Improvements For The Nation Act-Dec-2016
  - Places State Approved Programs As Primary CCR Enforcement
  - Gives EPA Subtitle D Enforcement If State Program Not Approved
    - EPA -“CCR State Permit Program Guidance Document-Interim Draft”- August 10, 2017

- ELG Stay Of Deadlines & Reconsideration – 4/12/17

- EOs – Regulatory Burden Reduction
  - 13777: Reform & Reduction Task Reviews
  - 13771: Regulatory Reduction – 2 For 1
    - 13783: Suspend, Revise or Rescind Domestic Energy Burden Regs

- Request For Input On Regulatory Burden Candidates – 5-15-17
  - Industry Requests For Delay Of CCR Deadlines & Modifications
CCR Recent Regulatory Actions

- OSM Regulatory Schedule - CCR Removed – States Will Control
- CCR Law Suit Actions – Oral Argument Scheduled – 10-17-17
  - CCP Issue - Beneficial Use > 12,400 tons versus Smallest Landfill @ 80K Tons - Math Error
  - April 18, 2016 EPA Brief - Admitted Math Error But Said No Duty To Stick To 80K Ton
  - USWAG Reconsideration Petition - 5-12-17 - For All Challenged Issues
  - EPA Filed Request - 9-18-17 Asking For 120 Day Delay In Oral Arguments
    - EPA Will Define Which Portions Of The Rule It Will Reconsider, If Any
    - EPA Points To WIIN Act & Issues Related To State Approvals
- ACAA Pushing EPA To Restart The C2P2 Program
- EPA TSCA Reg-Neg Committee – CDR For Inorganic Byproducts
  - CCP Product Reporting When Placed In Commerce
  - Committee Consensus Not Met – Further EPA Action Subject To Resources

- Section 2301 – Approval of State Programs For Control Of CCR
- State Option To Authorize For CCR Permit Program
- State Program Must Be At Least As Protective
- EPA Has 180 Days To Act On “Complete Application”
- EPA May Approve In Whole Or Part Of State Program
- Once Approved States Enforce In Lieu Of Citizens/EPA
- State Program Review Every 12 Years
- Approval At Regional Administrator Level w/ HQ Concurrence
CCR Status - Traditional - 2015 Data

- Cement 2016 Usage 101MTon-Up
- CCR Production-2015-117.3 M- Down
- Beneficial Use-2015, 61.1MT-52%- Up
- CCRs 3%+ Of Cost Of New Home
- 50% Of Wallboard Has CCR
## 2015 Coal Combustion Product (CCP) Production & Use Survey Report

### 2015 CCP Categories

<table>
<thead>
<tr>
<th>CCP Categories</th>
<th>Fly Ash</th>
<th>Bottom Ash</th>
<th>Boiler Slag</th>
<th>FGD Gypsum</th>
<th>FGD Material Wet Scrub</th>
<th>FGD Material Dry Scrubbers</th>
<th>FGD Other</th>
<th>FBC Ash</th>
<th>CCP Production / Utilization Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CCPs Produced by Category</td>
<td>44,365,587</td>
<td>12,010,425</td>
<td>2,228,205</td>
<td>32,661,536</td>
<td>11,313,960</td>
<td>1,311,947</td>
<td>206,314</td>
<td>13,191,460</td>
<td>117,289,432</td>
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<td>Total CCPs Used by Category</td>
<td>24,062,786</td>
<td>4,819,205</td>
<td>1,866,912</td>
<td>17,058,178</td>
<td>1,249,438</td>
<td>252,849</td>
<td>20,697</td>
<td>11,723,843</td>
<td>61,053,908</td>
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<tr>
<td>1. Concrete/Concrete</td>
<td>15,737,238</td>
<td>570,092</td>
<td>33,290</td>
<td>409,134</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>16,749,754</td>
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<tr>
<td>2. Blended Cement/Raw Feed for</td>
<td>3,629,151</td>
<td>1,130,802</td>
<td>-</td>
<td>1,649,934</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6,409,887</td>
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<tr>
<td>3. Flowable Fill</td>
<td>107,263</td>
<td>9,106</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>116,369</td>
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<tr>
<td>4. Structural Fills/Embankments</td>
<td>1,277,356</td>
<td>1,561,531</td>
<td>305,770</td>
<td>100,940</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4,447,462</td>
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<tr>
<td>5. Road Base/Sub-base</td>
<td>178,281</td>
<td>311,779</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>490,081</td>
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<tr>
<td>6. Soil Modification/Stabilization</td>
<td>216,483</td>
<td>66,253</td>
<td>-</td>
<td>8,053</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>290,789</td>
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<tr>
<td>7. Mineral Filler in Asphalt</td>
<td>52,784</td>
<td>-</td>
<td>14,176</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11,479</td>
<td>-</td>
<td>78,440</td>
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<tr>
<td>8. Snow and Ice Control</td>
<td>-</td>
<td>527,695</td>
<td>-</td>
<td>77,935</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>605,630</td>
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<tr>
<td>9. Blasting Grit/Roofing Granules</td>
<td>-</td>
<td>184,712</td>
<td>1,400,455</td>
<td>173</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>10. Mining Applications</td>
<td>1,128,682</td>
<td>73,416</td>
<td>-</td>
<td>807,280</td>
<td>-</td>
<td>215,974</td>
<td>-</td>
<td>11,593,760</td>
<td>13,819,113</td>
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<tr>
<td>11. Gypsum Panel Products</td>
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<td>28,378</td>
<td>-</td>
<td>11,322,016</td>
<td>973,785</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>12,324,178</td>
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<td>12. Waste</td>
<td>1,138,078</td>
<td>242</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9,218</td>
<td>130,083</td>
<td>-</td>
<td>1,277,621</td>
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<tr>
<td>13. Agriculture</td>
<td>2,409</td>
<td>1,788</td>
<td>-</td>
<td>1,392,693</td>
<td>174,713</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,571,602</td>
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<td>14. Aggregate</td>
<td>-</td>
<td>173,472</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>173,472</td>
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<tr>
<td>15. Oil/Gas Field Services</td>
<td>181,907</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>36,875</td>
<td>-</td>
<td>-</td>
<td>218,782</td>
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<tr>
<td>16. Miscellaneous/Other</td>
<td>413,152</td>
<td>179,940</td>
<td>35,265</td>
<td>247,030</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>875,387</td>
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</tbody>
</table>

### Summary Utilization to Production Rate

<table>
<thead>
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<th>CCP Categories</th>
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<td>20,697</td>
<td>11,723,843</td>
<td>61,053,908</td>
</tr>
<tr>
<td>Category Use to Production Rate</td>
<td>54.24%</td>
<td>40.13%</td>
<td>83.79%</td>
<td>52.23%</td>
<td>11.04%</td>
<td>19.27%</td>
<td>10.03%</td>
<td>88.87%</td>
<td>52.05%</td>
</tr>
</tbody>
</table>
Key 2017 Traditional Market Trends

• Coal Production – Through 9-16-17
  – YTD Production – 563.7M; Up 13.2% Over 2016 Same Period
    • Exports Projected Up 21% 17 over 16

• Current EIA Electricity Fuel Projections:
  – Coal Full Year: 2017 -31% v 2016 - 30%
  – Nat Gas Full Year: 2017 - 31% v 2016 - 34%;
    • Higher Gas Prices
    • Operations Improvements
  – 2018 Projection: Nat Gas 31% & Coal 32%

• Electricity Demands – Expected Flat
  – Hurricane Impacts Regional Demand

• Construction – Strong Early – Slowing Mid-Year
US Cement Usage – Strong Early

Cement Usage- Short Tons

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

2014 2015 2016 2017
- EIA Announced Closures-July 2017- Coal Reduction 57M+ TPY; Ash Lost – 3.9M TPY Fly Ash; 1M TPY Bot Ash
- CCR Deadlines Also Drive Planned Closures – Groundwater & Location
- Potential Impacts Of ELG Stay & Potential CCR Deadline Stay

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Units</th>
<th>Net Summer Capacity (MW)</th>
<th>BIT Closure</th>
<th>SUB Closure</th>
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<tbody>
<tr>
<td>2017</td>
<td>17</td>
<td>3,602</td>
<td>3,091</td>
<td>511</td>
</tr>
<tr>
<td>2018</td>
<td>22</td>
<td>7,922</td>
<td>5,352</td>
<td>2,570</td>
</tr>
<tr>
<td>2019</td>
<td>9</td>
<td>1,584</td>
<td>1,128</td>
<td>456</td>
</tr>
<tr>
<td>2020</td>
<td>2</td>
<td>788</td>
<td>118</td>
<td>670</td>
</tr>
<tr>
<td>2021</td>
<td>7</td>
<td>1,496</td>
<td>519</td>
<td>977</td>
</tr>
<tr>
<td>2022</td>
<td>2</td>
<td>862</td>
<td>180</td>
<td>682</td>
</tr>
<tr>
<td>2023</td>
<td>2</td>
<td>490</td>
<td>490</td>
<td>0</td>
</tr>
<tr>
<td>2024</td>
<td>2</td>
<td>90</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>2025</td>
<td>2</td>
<td>1,350</td>
<td>0</td>
<td>1,350</td>
</tr>
<tr>
<td>2028</td>
<td>2</td>
<td>250</td>
<td>250</td>
<td>0</td>
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<tr>
<td>Totals</td>
<td>67</td>
<td>18,434</td>
<td>11,218</td>
<td>7,216</td>
</tr>
</tbody>
</table>

Announced Closing-July 2017

[Graph showing Announced Closures]
Beneficial Use Trends & New Markets

• Plant Closure & Lower Capacity Factors
  – Gas Prices Higher – Renewables Higher– Capacity Factors-Nuclear & Coal

• Energy Civil Wars
  – Protectionist Actions To Protect Jobs – NY Credit $18+/MWH - Jobs
  – Renewables & Grid Reliability Impacts – California Eyes Western ISO - Pricing
  – Excel Separation Of ND & MN Due To Competing Energy Objectives
  – Renewable Tax Credits Vs. CO2 Reduction & Efficiency Credits –Coal States

• CCP Impacts
  – CCR Rules Drive Reclamation & Increase Usable CCPs
    • NGO Pressure For Clean Closure – Push Beneficial Use - Market Balance
    • In Certain Markets Reclamation of Ash Must Fill Voids In Certain Markets
  – Specification Fly Ash Shortage Regional Markets-Boston, CA, FL
  – Rail & Barge Movements Increase- Foreign Subsidized Shipments – Beneficiation
    CAPX Expands
  – Bottom Ash LWA Losses Must Be Met With Manufactured LWA
  – Wallboard Plants Seek Back-up Sources – Mined Gypsum Must Fill Void

• CCP Rare Earth Elements – Future Opportunity
REE – Opportunity Focus

- REE Are Crucial For Advanced Materials And Key Industries-Electronics, Automotive, Energy Etc. – Impacts $2.3 Trillion Of US Imports Finish Goods
- China Is The Saudi Arabia Of REE – 90+% Of Current Supply
- Strategic Interests Dictate That We Develop A Domestic Supply - Congress Mandate To Assess - In Strategic And Critical Materials Stockpiling Act For FY 2017
- Global Demand – 165KTPY - US-11% Of Total
- Crustal Average Concentration – 184ppm
- Coal And Related Products - >300ppm
- DOE Funded Projects
  - Assess Sources >300ppm
  - Develop Process - 300ppm to 2%
  - Assess Economic Viability
  - Assess Environmental Impacts
- Study Success
  - Met Goal 300ppm To 2%
  - Move To Pilot Plant Demo Phase
Three New DOE Projects (June 2017)
- 3 Test & Pilot Design
- Coal Prep Byproducts
- Anthracite, ILB & APP

Four DOE Funded Projects Move To Phase II (August 2017)
- 2 Bench Scale Projects
- Lignite & AMD
- 2 Pilot Scale Projects
- Fly Ash & Coal Prep Fines
- Focus On Pilot Scale Production

Schedule Results – 2020 Target For Pilot Plant & Economic Assessments

Independent R & D Ongoing Of DOE

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>Research Host</th>
<th>Location</th>
<th>Materials</th>
<th>Process</th>
<th>DOE ($000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bench Scale</td>
<td>University of Wyoming</td>
<td>Laramie, WY</td>
<td>PRB Coal Ash</td>
<td>CO2, FeChloride under Supercritical Conditions</td>
<td>660</td>
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<tr>
<td>2 Bench Scale</td>
<td>Duke University</td>
<td>Durham NC</td>
<td>Various CCB</td>
<td>Solvent Extract &amp; Membrane Filtration</td>
<td>720</td>
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<tr>
<td>3 Bench Scale</td>
<td>West VA University</td>
<td>Morgantown WV</td>
<td>NApp Coal Mine Drainage</td>
<td>Extraction from AMD &amp; AMD Sludges</td>
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<tr>
<td>4 Bench Scale</td>
<td>Batelle</td>
<td>Columbus OH</td>
<td>OH Coal &amp; Ash</td>
<td>Closed Loop Digestion</td>
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<tr>
<td>5 Bench Scale</td>
<td>University of North Dakota</td>
<td>Grand Forks, ND</td>
<td>ND Lignites &amp; Refuse</td>
<td>Separate, Extr &amp; Concentrate</td>
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<tr>
<td>6 Pilot Scale</td>
<td>University of KY</td>
<td>Lexington KY</td>
<td>Central App Prep Refuse</td>
<td>Qtr TPY Physical &amp; Chemical Separation</td>
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<td>7 Pilot Scale</td>
<td>Physical Sciences, Inc</td>
<td>Andover MA</td>
<td>Ash E KY Fire Clay &amp; Anthracite Refuse</td>
<td>1-5 TPD Physical-Chemical Separation</td>
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<td>8 Pilot Scale</td>
<td>Southern Res Institute</td>
<td>Birmingham AL</td>
<td>Cent App &amp; E Bitum Coal</td>
<td>Plasma Based Testing on Ash</td>
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<tr>
<td>9 Pilot Scale</td>
<td>Tusaar Inc</td>
<td>Lafayette, CO</td>
<td>KY &amp; OH Coal Ash</td>
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<td>10 Sample &amp; Characterize</td>
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<td>11 Sample &amp; Characterize</td>
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<td>Sample &amp; Characterize</td>
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<td>Morristown NJ</td>
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<td>Sample &amp; Characterize</td>
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<td>13 Sample &amp; Characterize</td>
<td>Equinox Chemicals LLC</td>
<td>Albany GA</td>
<td>Coal &amp; Coal By-Products</td>
<td>Sample &amp; Characterize</td>
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<td>14 Test &amp; Pilot Design</td>
<td>Inventure Renewables</td>
<td>Tuscaloosa, AL</td>
<td>PA Anthracite Coal Mine Mat’l</td>
<td>Test &amp; Pilot Pit Design</td>
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<tr>
<td>15 Test &amp; Pilot Design</td>
<td>Marshall Miller &amp; Assoc</td>
<td>Bluefield WV</td>
<td>WV Coal Prep Plant Byproducts</td>
<td>Test &amp; Pilot Plant Design</td>
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<tr>
<td>16 Bench Scale Test</td>
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<td>Grand Forks ND</td>
<td>ND Lignite &amp; Related Mat’ls</td>
<td>Phase II</td>
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<td>17 Bench Scale Test</td>
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<td>Morgantown WV</td>
<td>WV Appalachian Coal Mine AMD</td>
<td>Phase II</td>
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<td>18 Pilot Scale Design</td>
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<td>Andover MA</td>
<td>Central AF Fly Ash-Trapp KY</td>
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<td>6,000</td>
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<td>19 Pilot Scale Design</td>
<td>Univ KY</td>
<td>Lexington KY</td>
<td>Coal Prep Fines-Cent APP &amp; ILB</td>
<td>Phase II</td>
<td>6,000</td>
</tr>
</tbody>
</table>
• REE In CCPs – Joint Processes
  • REE Processes May Include Beneficiation For Traditional Uses
    • Initial Step Process- Fly Ash Pozzolan
    • REE Separation Process – Clean Fly Ash

• Ponds & Landfills – Large Feedstock – 1.5B-2.5B Tons
  • Access Is Key Under State CCR Rules – Closure & Post Closure

• Next Generation Power Plants Incorporate Processes
  • Capture REE Before Encapsulation Into Glass Fly Ash Matrix
  • Dual Income Streams – Energy & Materials
  • Dual Co-Product Income – Ash & REE Materials
Summary - CCP/REE Opportunities

• Coal Use Will Be Impacted By Cheap Natural Gas (Capacity Factor) & Regulatory Impacts (Closures)
  – Current Administration Reviews May Reduce Regulatory Timed Impacts

• CCP Use As A Valued Resource Continues
  – Demand Increasing As Economy Grows – Infrastructure Impacts State $$
  – Volumes Impacted In Certain Markets – Closings & Capacity Factor
  – Quality Impacted By Regulation-Reclamation & Beneficiation Investment
  – Supply/Demand Economics Will Raise Prices
  – Future Opportunities May Include REE Extraction & Processing

• State Energy & CCR Programs – Address Current & Future Needs
  – War Between States Strategy – Jobs Matter
  – State Control Of CCR – Prompt State CCR Program Submittal
  – Enhance Resource Recovery & New Opportunities For CCPs & REE
  – Ensure Federal & State Tax Policies & Funding For Logical Energy Decisions & Environmental Protection
QUESTIONS

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Charah, LLC
May 22, 2017