Building an Iron-Clad BACT Attack 
Avoiding Imposition of Carbon Capture and Sequestration (CCS) on Your Next Major Expansion

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Acronyms

BACT  Best Available Control Technology
CCS   Carbon Capture and Sequestration
EPA   US Environmental Protection Agency
GHG   Greenhouse Gas
GWP   Global Warming Potential
MRR   Mandatory Reporting Rule
NSR   New Source Review
PSD   Prevention of Significant Deterioration
WCI   Western Climate Initiative
TLA   Three Letter Abbreviation
IDK   I Don't Know
Bad News for the TX Cattleman's Association: The 400-page U.N. Report Indicates Flatulence from Cattle Generates More GHG Emissions than All Cars, Trucks and Airplanes Combined!!!

As an Aside, There are Many Paths to a Carbon Tax...
USEPA recently re-proposed a New Source Performance Standard (NSPS) for Utilities (announced 9/20/13)

- Will only impact NEW utility sources
- Emission limits are VERY STRICT – equivalent to a natgas-fired combined-cycle facility – if successful, this regulation will effectively eliminate the construction of future coal-fired power plants in the US
  - New coal-fired power plants will be required to install carbon capture and sequestration systems to capture at least a portion (30-50%) of their CO2 emissions.
- Note: Proposed NSPS regulations are effective on the date of publication in the FedReg
- Received 3 million comments on the initial 2012 proposal
- Final regulation likely issued next year (2014)
- NSPS for refiners will likely be next GHG NSPS issued
BACT – What is it?

Best Available Control Technology
Five Steps in the Top Down BACT Analysis

1. Identify All Available Control Options for the Source
2. Eliminate Technically Infeasible Control Options
3. Rank Remaining Technically Feasible Control Technologies by Control Effectiveness;
4. Assess Economic, Energy and Environmental Impacts of each Remaining Option
5. Highest Ranked Technology Remaining after Step 4 is Selected as BACT
Example: How the BACT Process Works Over Time. . .

For each source type discussed later in this talk, the newly issued PSD permits will set the national precedent for the level of CO\textsubscript{2} emissions and/or the level of energy efficiency for that type of equipment. Permits in later years will be forced to adopt newer, more efficient technologies and processes. End the end, GHG BACT will follow a path similar to that followed above by NOx emissions in the last 30 years.

EPA's proposed first-time utility greenhouse gas (GHG) rule for new plants sets a heat-rate limit, a measure of fuel efficiency, a level so strict it signals an end to new coal plants as only gas-fired facilities will be able to meet the limit unless 30-50% of the CO\textsubscript{2} is captured.
We Are Seeing a Similar Trend Develop for GHG. . .

- We have seen USEPA comments on 38+ permits. . .
  - A wide variety of permits from tire-derived fuel facilities to bio-mass fired to chemplants received their permits
  - Heat-rates (# CO$_2$/MW, or # CO$_2$/Bbl crude, etc.) and/or production efficiencies for many of these sources are being defined.
  - Agencies are comparing one source’s heat-rate or efficiency to other similar sources.
  - Sources with higher heat rates (lower efficiencies) are faced with defending their selection of control technologies.
  - As with the NO$_x$ BACT progression, the CO$_2$ emission limits, in the form of heat-rates or production rates, will drop over time.
  - USEPA calls this practice “benchmarking.” (See their March’11 guidance)
The Table Below from a Recent Region 6 Cracker Permit Demonstrates that USEPA has Already Started Benchmarking Facilities.

USEPA compares the relative efficiencies of INEOS, BASF and Williams crackers.

<table>
<thead>
<tr>
<th>Permit</th>
<th>Williams Olefins LDEQ PSD-LA-759</th>
<th>BASF- Region 6 PSD-TX-903-GHG</th>
<th>Proposed INEOS-Region 6 PSD-TX-97769</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel composition</td>
<td>2 ethylene crackers each 182MMBtu/hr</td>
<td>One ethylene furnace rated 498MMBtu/hr</td>
<td>One ethylene crackers rated 495MMBtu/hr</td>
</tr>
<tr>
<td>Fuel composition</td>
<td>25% hydrogen in process gas</td>
<td>Fuel monitoring required.</td>
<td>35% hydrogen in fuel maintain a 0.71 carbon percentage in fuel</td>
</tr>
<tr>
<td>Feed composition</td>
<td>Only ethane gas</td>
<td>Liquid and gaseous</td>
<td>Ethane gas only</td>
</tr>
<tr>
<td>Furnace Efficiency</td>
<td>92.5%</td>
<td>Not stated</td>
<td>92.6%</td>
</tr>
<tr>
<td>Production B#/year</td>
<td>0.55</td>
<td>0.42</td>
<td>0.509</td>
</tr>
<tr>
<td>emissions CO2e (tpy)</td>
<td>182,265 tpy</td>
<td>256,914 tpy</td>
<td>216,567 tpy</td>
</tr>
<tr>
<td>Output rates (# CO2e/lb of ethylene)</td>
<td></td>
<td>1.22</td>
<td>0.85</td>
</tr>
</tbody>
</table>
In Another Table, Extracted from a Recent Region 6 Statement of Basis, USEPA Compares Furnace Efficiencies and Annual Availabilitys...

<table>
<thead>
<tr>
<th></th>
<th>Overall Furnace Efficiency %</th>
<th>Annual Availability %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chosen Design</td>
<td>92.6</td>
<td>96.83</td>
</tr>
<tr>
<td>Design A</td>
<td>93.6</td>
<td>95.21</td>
</tr>
<tr>
<td>Design B</td>
<td>93.1</td>
<td>97.78</td>
</tr>
<tr>
<td>Design C</td>
<td>93.2</td>
<td>96.39</td>
</tr>
<tr>
<td>Design E</td>
<td>93.9</td>
<td>95.89</td>
</tr>
<tr>
<td>Existing (1993)</td>
<td>92.2</td>
<td>96.66</td>
</tr>
<tr>
<td>Existing (1976)</td>
<td>89.0</td>
<td>96.58</td>
</tr>
<tr>
<td>Existing (1973)</td>
<td>85.0</td>
<td>95.62</td>
</tr>
</tbody>
</table>
In a Third Table, USEPA Compares Ethane Usage Versus Ethylene Generation Rates Across Projects. . .

USEPA concludes that the most efficient furnace will result in the lowest overall emissions of GHG.

<table>
<thead>
<tr>
<th></th>
<th>Lbs ethylene/ lb ethane</th>
<th>High pressure Steam (Mlbs/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chosen Design</td>
<td>0.573</td>
<td>177</td>
</tr>
<tr>
<td>Design A</td>
<td>0.552</td>
<td>178</td>
</tr>
<tr>
<td>Design B</td>
<td>0.561</td>
<td>175</td>
</tr>
<tr>
<td>Design C</td>
<td>0.550</td>
<td>182</td>
</tr>
<tr>
<td>Design E</td>
<td>0.545</td>
<td>169</td>
</tr>
<tr>
<td>Existing (1993)</td>
<td>0.52</td>
<td>105</td>
</tr>
<tr>
<td>Existing (1976) &amp; (1973)</td>
<td>0.49</td>
<td>70</td>
</tr>
</tbody>
</table>
Strategies for Reducing Carbon Emissions
Controlling Carbon Emissions

There are three carbon reduction strategies:

- **Capture carbon emissions**
  - Carbon capture and sequestration (CCS)
  - Capture the CO$_2$, compress it and pump it to a subsurface reservoir (saline aquifers, enhanced oil recovery, etc.)
  - Very limited application; technology not proven on many source types; very expensive; high parasitic energy loads; sequestration sites may not be near facility
  - Sources may be pressured to control any high-purity CO$_2$ emissions via CCS
Controlling Carbon Emissions (cont’d)

Reduce carbon intensity

- Basically, fuel switching. Use fuels with fewer carbon atoms in the molecule.
- Example: Use natural gas instead of coal, fuel oil, or petcoke, reducing carbon emissions by ~50%.
- Potentially significant application in utility industry – significant pressure could emerge to convert coal plants to natgas by Sierra Club and other NGOs.
  - The new NSPS for GHG for the Utility industry would severely curtail coal use if it goes final in its current form.

<table>
<thead>
<tr>
<th>Fuel Name</th>
<th>CO₂ Emitted (lbs/10⁶ Btu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>117</td>
</tr>
<tr>
<td>Liquefied petroleum gas</td>
<td>139</td>
</tr>
<tr>
<td>Propane</td>
<td>139</td>
</tr>
<tr>
<td>Aviation gasoline</td>
<td>153</td>
</tr>
<tr>
<td>Automobile gasoline</td>
<td>156</td>
</tr>
<tr>
<td>Kerosene</td>
<td>159</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>161</td>
</tr>
<tr>
<td>Tires/tire derived fuel</td>
<td>189</td>
</tr>
<tr>
<td>Wood and wood waste</td>
<td>195</td>
</tr>
<tr>
<td>Coal (bituminous)</td>
<td>205</td>
</tr>
<tr>
<td>Petroleum coke</td>
<td>225</td>
</tr>
<tr>
<td>Coal (anthracite)</td>
<td>227</td>
</tr>
</tbody>
</table>
Controlling Carbon Emissions (cont’d)

Reduce energy intensity

- Basically, energy efficiency measures. Increasing operational efficiencies. Make the same quantity of electricity with less energy consumption. Make the same quantity of gasoline with less energy.

- In permits, instead of “emission rates per hour”, facilities will have “emission rates/unit of production.”

- Examples: # CO₂/MW produced; # CO₂/ton of product; #CO₂/barrel of crude throughput.

USEPA came to the same conclusion we did: the only feasible path for reducing GHG in the US is Reducing Energy Intensity (i.e. energy efficiency projects) with some limited application of fuel switching, especially in the utility industry.
Many “Tried And True” Technologies Can be Used to Reduce Your Carbon Emissions Without the Need for Carbon Capture and Sequestration.

No single technology will get you to the industrial facility of the future...
Can My Facility Avoid Imposition of Carbon Capture and Sequestration?
**CO\textsubscript{2} Capture and Sequestration**

- **Power Station/Industrial Facility**

  - 500m
  - 1000m
  - 1500m

  - **CO\textsubscript{2} Stored in Saline Formation**
  - **CO\textsubscript{2} Replaces Methane Trapped in Coal**
  - **CO\textsubscript{2} Stored in Saline Reservoir**
  - **Enhanced Oil Recovery (CO\textsubscript{2} Displaces Oil)**

- **SALINE RESERVOIR**
  - **IMPERMEABLE CAP-ROCK**

- **Coal Seam**
  - **IMPERMEABLE CAP-ROCK**

**Enhanced Oil Recovery**

- **OIL**
- **CH\textsubscript{4}**

**CO\textsubscript{2} Capture**

- **CO\textsubscript{2} Capture and Sequestration**
- **CO\textsubscript{2} Capture and Storage**
- **CO\textsubscript{2} Enhanced Oil Recovery**
- **CO\textsubscript{2} Geological Sequestration**
- **CO\textsubscript{2} Storage in Saline Formations**
- **CO\textsubscript{2} Sequestration Technologies**

**CO\textsubscript{2} Emission Reduction**

- **Industrial Processes**
- **Power Plants**
- **Transportation**
- **Agriculture**
- **Lumber Industry**

**CO\textsubscript{2} Utilization**

- **Enhanced Oil Recovery**
- **Enhanced Gas Recovery**
- **Enhanced Geothermal Systems**
- **Enhanced Coalbed Methane Recovery**
- **Enhanced Saline Solution EOR**

**CO\textsubscript{2} Capture and Transport**

- **Pre-combustion Capture**
- **Post-combustion Capture**
- **Oxy-fuel Combustion**
- **Pre-combustion Capture**
- **Direct Air Capture**

**CO\textsubscript{2} Storage**

- **Saline Formations**
- **Geologic Sequestration**
- **Enhanced Oil Recovery**
- **Enhanced Gas Recovery**
- **Enhanced Geothermal Systems**
- **Enhanced Coalbed Methane Recovery**
- **Enhanced Saline Solution EOR**
What Does the USEPA BACT Guidance Have to Say About CCS?

The guidance states that:

- “Although CCS is not in widespread use at this time, EPA generally considers CCS to be an ‘available’ add-on pollution control technology for large CO₂-emitting facilities and industrial facilities with high-purity CO₂ streams.”

- “While CCS is a promising technology, EPA does not believe that at this time CCS will be a technically feasible BACT option in certain cases.”

- “the term ‘applicable’ generally means a technology can reasonably be installed and operated on the source type under consideration.”
What Does the USEPA BACT Guidance Have to Say About CCS? (cont’d)

- It adds that “[a] permitting authority may conclude that CCS is not applicable to a particular source, and consequently not technically feasible, even if the type of equipment needed to accomplish the compression, capture, and storage of GHGs are determined to be generally available from commercial vendors.”

- The BACT guidance also states that “there may be cases at present where the economics of CCS are more favorable (for example, where the captured CO₂ could be readily sold for enhanced oil recovery)…”

- For the vast majority of situations, CCS will be eliminated in BACT analyses…but in a few years, it may be a different story.
Many Facilities Have Avoided Imposition of CCS...

- 38+ permits for GHG were issued in the US in the last 24 months that USEPA reviewed and offered their comments.
- Many of these facilities successfully avoided imposition of CCS even though the vast majority had to include CCS in their 5-Step, top-down BACT analysis.
- What types of arguments were used by these entities to successfully avoid imposition of CCS?
  - There were lessons to be learned from all.
Background - BACT CCS Strategy

- Under Step 4 of the top-down BACT analysis, permitting authorities must consider the 1) economic, 2) energy, and 3) environmental impacts arising from each option remaining under consideration.

- The “top” control option should be established as BACT unless it can be demonstrated that the energy, environmental, or economic impacts justify a conclusion that the most stringent technology is not appropriate.

- A BACT analysis where CCS is one of the feasible technologies must focus on those three primary and multiple other secondary arguments (discussed on the following slides).

- An detailed, well-documented BACT analysis will help facilities avoid lawsuits and permit delays associated with activists challenging your permit.
Background - BACT CCS Strategies

1. Detrimental to the Environment

- This should be an easy argument to make!
- There will be significant pollutant emissions associated with the parasitic power (25-40%) required to capture, purify and compress the CO$_2$ emitted by the facility
- Significant add’l emissions of NO$_x$, CO, SO$_2$, particulate matter, and other pollutants will be emitted due to the parasitic energy loads and steam requirements
- A 25-40% add’l pollutant load on the local community is a heavy burden to ask of the locals
Background - BACT CCS Strategies (cont’d)

1. Detrimental to the Environment (cont’d)

- Characterize those emissions resulting from the parasitic load and document them in detail in your BACT analysis.

- Remember, NO\textsubscript{x}, SO\textsubscript{2} and PM all have health impacts; CO\textsubscript{2} is something we EXHALE and trees love!

- Determine the local background burden of NO\textsubscript{x}, SO\textsubscript{x} and PM and add the modeled burden to it.

When considering the impact to the environment, be sure to consider multi-media impacts:

- There will be additional load on the wastewater system caused by the addition of the CCS equipment – Water use may double with the addition of CCS!

- There will be add’l solid and, perhaps, hazardous waste generated as a result of the CCS system...ash, slag, spent CCS sorbent, etc.
2. CCS is too costly

- Eliminating CCS due to cost should be fairly easy, when done correctly.

- Demonstrate that the cost effectiveness of CCS, when compared to other energy efficiency measures for the proposed facility, is poor.

  In other words, in “BACT speak,” demonstrate the “incremental cost effectiveness” of CCS is much lower than the incremental cost effectiveness of other technologies.
2. CCS is too costly (cont’d)

- The only factor that might complicate the cost calculation is if you can sell your CO$_2$ for enhanced oil recovery (EOR)
  
- While the economics are improved, the economics are typically still very poor. Paying $100+/ton to capture a commodity and selling it for $10/ton does not make for a profitable business!

- Costs for pre-combustion capture with compression, excluding costs of transport and storage, for initial “early adopter” solid-fuel installations are expected to range from $120 to 180/ton CO$_2$ avoided

- Later, “Nth” adopters’ costs are predicted to range from $35 to 70/ton CO$_2$ avoided, not including pipeline transport and sequestration
Even USEPA acknowledges that CCS is too expensive, *at this time*

In their guidance and in their comments on various permits, USEPA states that an applicant MUST include CCS as a “feasible technology” in BACT Step 1 even though they recognize that “it will likely be eliminated later due to cost.”

3. **CCS is too energy intensive.**

   - This, too, should be an easy argument to make
   - The parasitic loads associated with CCS are generally very high

   *DOE’s research *goals* are to develop CCS technologies for coal that have only a 20% parasitic load…still pretty high*
3. CCS is too energy intensive.

- Demonstrate that energy efficient engineering elsewhere within the facility offsets the need for CCS
- Identify all instances in the final design where energy efficiency was built into the proposed facility to reduce overall CO\textsubscript{2} emissions elsewhere within the complex
  - Identify design options such as high efficiency heat exchangers, high efficiency pumps, high efficiency fans, high efficiency lighting, extra heat recovery efforts, etc.
- Demonstrate that the design selected is inherently more efficient than other facilities constructed in the past. Benchmark your design against other recently permitted facilities in the same industry sector.

Now, let's change our focus a little bit...
Beyond the Industrial Site. . .

Outside the plant boundary, there is significant add’l CCS uncertainty. . .

Let’s explore some of those uncertainties. . .
Geological Formations Appropriate for Sequestration Cover Much of the US

- 60-70% of the US is underlain by geological formations appropriate for long-term sequestration of CO₂

- But, while there may be a reservoir beneath your facility, it does not mean it is a suitable/acceptable reservoir

- A potential reservoir must undergo extensive and prolonged testing to verify the geology will support sequestration
Much of the US has Geological Formations Appropriate for Sequestration (cont’d)

- If there is an appropriate sequestration reservoir beneath your facility:
  - Is your facility prepared to undertake the years of geologic testing required to determine if the reservoir meets appropriate specs?
    - Literature indicates it takes from one to seven years to demonstrate a reservoir is suitable
  - Has your state passed laws accepting long-term (100,000+ years) liability for any CO$_2$ that is sequestered? If not, is your management willing to accept the liability of storing a known asphyxiant in the subsurface for 100,000 years?
    - MT, ND, and LA will accept liability for the CO$_2$ after the sequestration site is proven to be suitable/stable
Much of the US has Geological Formations Appropriate for Sequestration (cont’d)

Futuregen, the world’s first near-zero emissions power plant, would not build in a TX or IL unless the state gave them indemnification against leakage of the CO₂. Both states passed laws and accepted the liability.

Has the legal issue of “who owns the underground pore spaces” in the subsurface been resolved in your state? This is a huge legal issue (except, perhaps, in WY and ND.)

Are you prepared to permit and drill a UIC Class 6 injection well? The process can be arduous and take several years. The public is not a big supporter of underground injection.

Is your management willing to accept the liability and public outcry associated with all future earthquakes in the area, like the blame being directed at, probably wrongly, the “fracking” business in OH and OK?
Much of the US has Geological Formations Appropriate for Sequestration (cont’d)

- The Monitoring, Verification and Accounting (MVA) requirements required as part of a CO$_2$ injection process is massive and costly
- Do not overlook the inclusion of these costs when developing your BACT cost projections
- The MVA system for FutureGen is estimated to cost $50 million
Very Few U.S. Facilities Have Access to a CO$_2$ Pipeline...

- As the map illustrates, there are very few CO$_2$ pipelines in the US.
- Even if your facility is within 100 miles, can your project afford the cost and time to buy the ROWs, design the pipeline, and construct it?
- Is your management willing to assume the liability and public scrutiny of running a high-pressure pipeline containing an asphyxiant under high-pressure through populated areas?
- If the CO$_2$ pipeline carrier leaves the business after a few years, what is your contingency plan? If the pipeline operation is disrupted for a day or a week, what is your contingency? When the initial term of your contract ends, can you afford the escalation rates?
EPA is Treading Softly…But Not for Long!

USEPA has not had a “heavy foot” in the last two years - 2011-2012 were years of “setting the baseline.”

- Many types of facilities received permits where their GHG emissions were permitted at their “potential to emit” – a rate equal to their maximum theoretical emissions rate.
- No major requirements from USEPA to reduce GHG emissions as long as the facility could demonstrate some efficiency measures were implemented.

In Sept, EPA re-proposed a precedent-setting NSPS for new utilities.

- Once that dust settles, USEPA will work with the states to develop a plan for existing utility plants.
- The Utility actions will be followed by an NSPS for refiners. Chem/Petrochem will likely be next.
- Future regs could be very strict – requiring much higher efficiencies than previously tolerated.
Wrapping Up...
What Can A Facility Do?

- Begin evaluating BACT options now.
  - Thoroughly document energy efficiencies in new expansions
  - Any easy methane sources that can be captured? (1 ton of CH$_4$ = 21 tons on CO$_2$). Any PFC sources where the GWP ratio is 6,000 tons to 1?
  - Any best practices that can be implemented?
  - Is fuel switching an option? Natgas instead of petcoke?
- Verify that there are no CO$_2$ pipelines within 50-100 miles of your facility.
- Verify there are no geological sequestration sites nearby that have already been tested and verified for use
Confirm that your project will not have any “high-purity” CO$_2$ streams being emitted.

- What is “high purity”? Likely not as high as you think
- URS is encouraging clients with sources containing greater than 30% CO$_2$ to construct a more robust BACT analysis than they might otherwise prepare
- Recognize that most boilers, heaters, turbines, RICE engines emit CO$_2$ in the 4-12% range and are likely “safe” from being forced to install CCS
What Can A Facility Do? (cont’d)

USEPA has reviewed several permits with high-purity CCS streams and has not yet forced any to install CCS

All were forced to add CCS to their top-down BACT analyses if CCS had not already been included

Thoroughly document the anticipated cost of the CCS system – don’t just assume CCS can be discounted as too expensive. You will likely have a permit delay if you do not.

If a facility does not include CCS in their BACT analyses for every fired source, it will likely result in the facility having a permit delay while CCS is added to your permit application

You must submit a BACT analysis for every type of source, including emergency generators and other small sources. USEPA has forced several permit applicants to re-submit their applications over this issue
What Can A Facility Do? (cont’d)

- Include emissions of non-CO\(_2\) GHGs – methane and N\(_2\)O – for all combustion sources – or plan to re-do the permit application.

- Carefully document all assumptions in the BACT analysis – if a technology is rejected, carefully document why.

- Explicitly address all five of EPA’s Top-Down Steps – or be ready to re-do the permit application.

- Bottom line: documentation of GHG control technology, efficiency considerations and enforceable emission limits is important for a proper record to reduce agency comments and intervener objections.
Questions?
Complete Lifecycle Solutions

URS delivers the full range of environmental, engineering, construction, and management solutions in 15 major markets across the globe.
Greenhouse Gas Services

As the premier provider for GHG solutions, URS supplies integrated, class-leading regulatory compliance, project execution as well as knowledge and expertise in offset options in the fields of carbon monitoring and control.

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