Green House Gas (GHG) Best Available Control Technology (BACT) - Where do We Stand after One Year of EPA's Regulation of GHG Emissions?

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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

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A Few of the Broader Issues/Questions We Hope to Address this Afternoon…

- How has USEPA's new GHG Program functioned in the last year?
- Has it been the onerous program we expected?
- What types of stringent requirements have been imposed upon industry?
- Has Carbon Capture and Sequestration (CCS) become a wide-spread requirement?
- How can an industrial facility avoid imposition of CCS?
- What specific controls have been required?

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First, a Little Background Data. . .

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Unlike Conventional Pollutants like NO_x and SO_2, GHG are Controlled Based on Tons of "CO_2e" – "CO_2 Equivalents"

Gas		GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_20	310
Hydrofluorocarbons (HFCs)	HFC-23	11,700
	HFC-32	650
	HFC-125	2,800
	HFC-134a	1,300
	HFC-143a	3,800
	HFC-152a	140
	HFC-227ea	2,900
	HFC-236fa	6,300
	HFC-4310mee	1,300
Perfluorocarbons (PFCs)	CF_4	6,500
	C_2F_6	9,200
	C_4F_{10}	7,000
	C_6F_{14}	7,400
Sulfur Hexafluoride	SF_6	23,900

Different GHGs have different global warming potentials (GWP). CO_2 was given a GWP of 1.

As the table illustrates, methane is 21 times worse than CO_2 and, therefore, has a GWP of 21.

Sulfur hexafluoride, used in high-voltage circuit breakers, has a GWP of 23,900.

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There are Four Paths that can Lead to U.S. Carbon Controls. . .

1. **EPA Regulation** -- The EPA imposes regulation on GHG emissions in the U.S. This is already here, as you may all know.
   - Note: The first legislative day of the 112th Congress, legislation was filed to prevent the Environmental Protection Agency from proceeding with regulation of industry GHG emissions. Expect more of this, this year.
2. **Legislation** -- Congress enacts a new comprehensive climate and energy legislation. (i.e. cap & trade, carbon tax, incentives)
3. **State or Regional Action** -- States take the initiative to create regional cap-and-trade schemes or other regulatory rules. *Calif AB 32, Participation in regional schemes like the WCI, etc.*
4. **Litigation** -- Legal challenges and filings result in outcomes that effectively contribute to GHG regulation.

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History of the Regulation of GHGs

- May 2007 – Supreme Court Ruling (Massachusetts v. USEPA)
- December 2009 – "Endangerment Finding" on GHGs
- April 2010 – GHG Emissions Standards for Light-Duty Vehicles
  - Industrial Source Permitting Triggered Beginning Jan. 2, 2011
- May 2010 – Tailoring Rule Limits GHG Air Permitting to the Largest Sources of GHG Emissions
- November 2010 – BACT Guidance, Technical Resources and Training to States and Sources on Implementation of GHG Permitting

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What Has USEPA Done to Regulate GHGs?

- **Tracking**…EPA's Mandatory Reporting Rule (MRR)

  Passed in 2009 - First reports were due in March 2011

- **Permitting**…. EPA's "Tailoring rule"

  June 2010 - Shoehorned or "tailored" the Clean Air Act to allow it to be used on GHGs rather than criteria pollutants (SO_2, NO_x, PM_{10}, etc.)

  The Tailoring rule specified what size GHG sources will require permits in the future under Title V

- **Controls. . .**EPA issued their BACT for GHG guidance

  November 2010

- **Taxation. . .** Not yet, unless you are in California.

  Requires US Congressional action which is no longer on the horizon. . .but could be, should Congress decide to pay off the deficit, in part, via a carbon tax.

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Imminent Future Regulations of GHG. . .

- USEPA is preparing to propose a New Source Performance Standard (NSPS) for Utilities in the next few months
  - Will only impact *NEW* utility sources
  - Proposed regulation currently at OMB
  - 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*
  - The regulation will be effective *on the date of proposal*
  - Once the Utility NSPS is proposed, USEPA will propose an NSPS for refiners (expected later this year)

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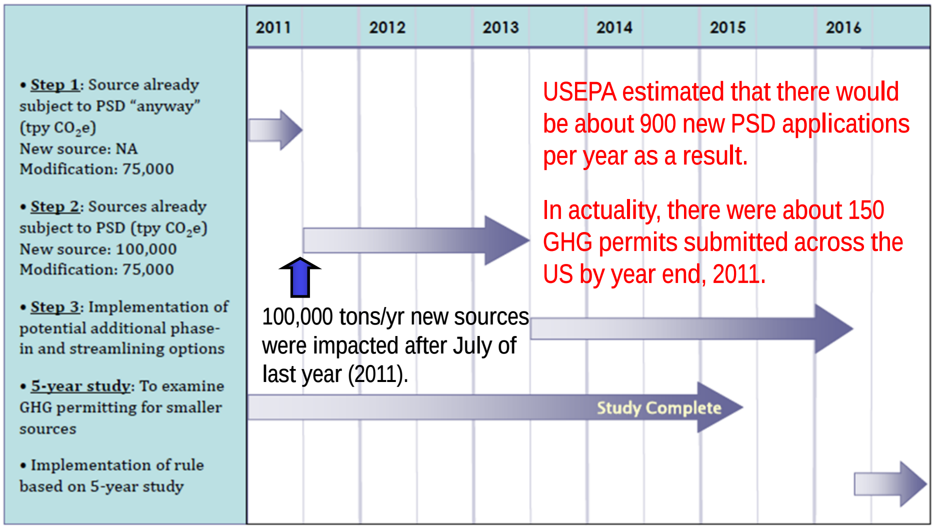
Permitting Phases under the USEPA's Tailoring Rule



So What Size Source Emits 100,000 TPY?

100,000 MTons/yr of CO_2e is equivalent to:

- ~200 MMBtu/hr of natural gas
  - Natural gas CO_2 emissions = 117 lbs of CO_2e/MMBtu
- ~100 MMBtu/hr of coal-fired sources
  - Coal CO_2 emissions = 227 lbs of CO_2e/MMBtu

Note: A typical coal-fired electric generating unit (EGU) will emit 10+ million tons/yr. A mid-sized refinery (125k BPD) and/or chemical plant will emit 2MM tons/yr of CO_2 , approximately 20 times the "per source limit" in the rule.

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BACT – What is it?

Best

Available

Control

Technology

EPA's "Top Down" BACT

- EPA policy since late 1980s.
- Required procedure for BACT determinations where EPA is the permitting authority, and encouraged for state agencies with approved permitting plans.
- Comprehensive technology review resulting in selection of "maximum degree of reduction," unless "*energy, environmental, and economic impacts and other costs*" justify rejection.

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

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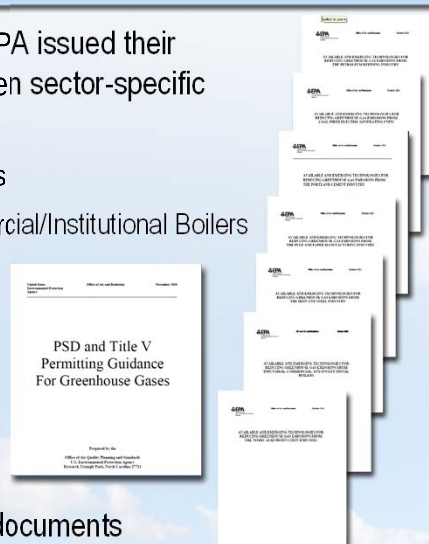
USEPA Issued Their BACT Guidance in Nov'10 *and Revised it in March'11*

- On Nov 10th, 2010, USEPA issued their BACT Guidance and seven sector-specific whitepapers:
  - Electric Generating Units
  - Large Industrial/Commercial/Institutional Boilers
  - Pulp and Paper
  - Cement
  - Iron and Steel Industry
  - Refineries
  - Nitric Acid Plants
- ~450 pages of technical documents



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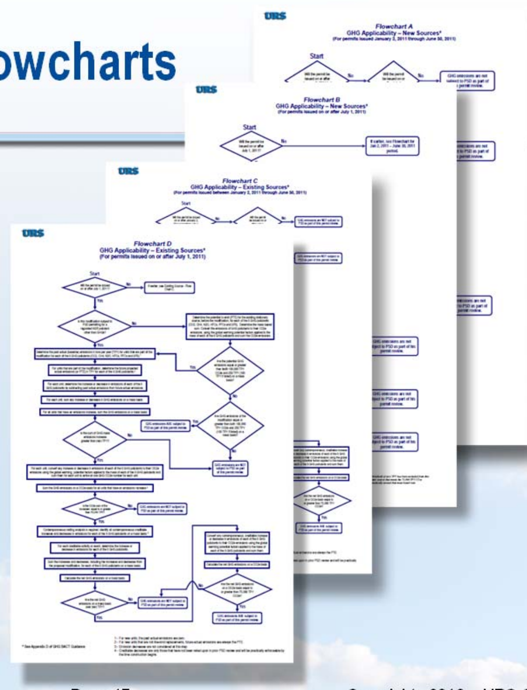
Decision Flowcharts

- Four applicability flowcharts for GHG BACT guidance and the Tailoring rule are available from URS to guide you through the applicability issues.
- These flowcharts summarize 12 pages of Appendices (A-D) of the BACT Guidance.

Note: Write “flowcharts” on a business card to request the flow charts.



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Example: How the BACT Process Works Over Time. . .

1980 Good combustion practices — 175+ ppm NOx

1990 Flue Gas Recirculation — 125+ ppm NOx

1995 Low-NOx Burners — 80+ ppm NOx

2000 Ultra Low-NOx Burners — 30+ ppm NOx

2008 Ultra-Low NOx Burners + SCR — 5+ ppm NOx

EPA's proposed first-time utility greenhouse gas (GHG) rule for new plants undergoing White House review sets a heat-rate limit -- a measure of fuel efficiency -- to reflect the best-performing combined-cycle natural gas plant, a level so strict it signals an end to new coal plants as only gas facilities will be able to meet the limit, sources say.

For each source type discussed later in this talk, the newly issued PSD permits will set the national precedent for the level of CO_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.

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We Are Seeing a Similar Trend Develop for GHG. . .

- We have seen USEPA and States act on 25+ permits
  - A wide variety of permits from tire-derived fuel facilities to bio-mass fired to refineries received their permits
  - Heat-rates (# CO_2/MW, or # CO2/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 lower heat rates (higher 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.

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Permitting Paradox: Tragically, the Major Source Permitting Process Currently Discourages Energy Efficiency

- Facilities that modify their plants can trigger the need for a major source permit.
- If a modification triggers major source permitting, it requires BACT controls.
  - BACT controls are typically high capital items and many have high annual O&M costs
- Many facilities avoid permitting *for decades* in order to avoid the high capital cost and annual O&M associated with BACT controls
  - Efficiency upgrades are foregone for fear they will trigger major source permitting
- The result is the continued use of outdated and inefficient equipment in thousands of facilities across the US.
- Thus, EPA's major source permitting regs inhibit the installation of newer, more energy efficient, lower emitting equipment.

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Permitting Paradox:
Tragically, the Permitting Process Currently Discourages Energy Efficiency (cont'd)

- This is tragic because energy efficiency upgrades offer the fastest and greatest potential for near-term and cost-effective GHG reductions.
- It is quite surprising that USEPA is using the major source permitting program, a program that is a big impediment to efficiency increases, to implement a new policy initiative to increase energy efficiency!
- The right step for USEPA to make would be to exempt energy efficiency projects from permitting altogether…not to chill it by requiring these projects to go through major source permitting review.

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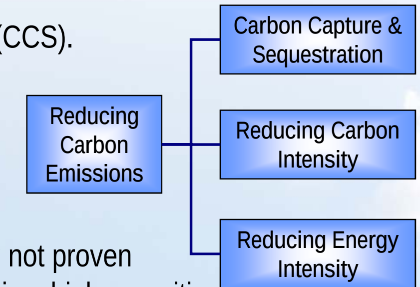
Controlling Carbon Emissions

There are only three carbon reduction strategies:

- Capture carbon emissions
  - Carbon capture and sequestration (CCS).
  - Capture the CO2, 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



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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 current NSPS for GHG for the Utility industry under review at OMB would severely curtail coal use if it goes through in its current form.

      Note: Coal states will likely defeat it and/or water it down.

Fuel Name	CO_2 Emitted (lbs/10^6 Btu)
Natural gas	117
Liquefied petroleum gas	139
Propane	139
Aviation gasoline	153
Automobile gasoline	156
Kerosene	159
Fuel oil	161
Tires/tire derived fuel	189
Wood and wood waste	195
Coal (bituminous)	205
Petroleum coke	225
Coal (anthracite)	227

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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: # CO_2/MW produced; # CO_2/ton of product; #CO_2/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.*

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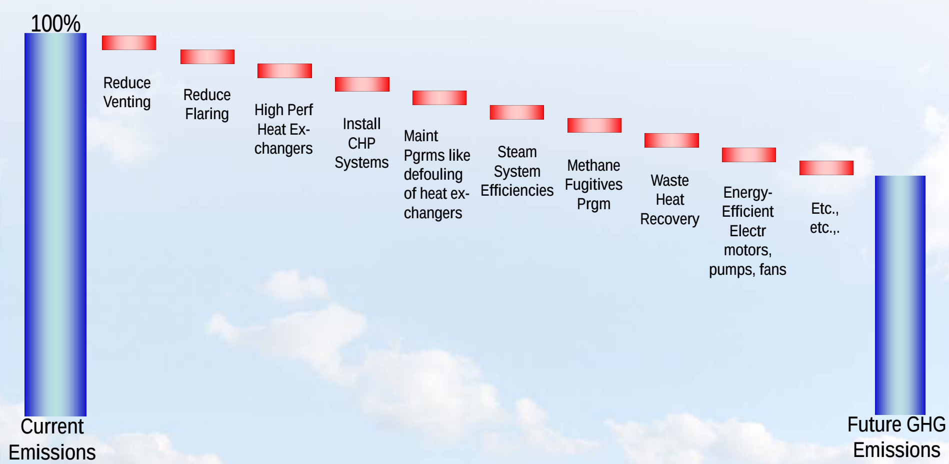
No Single Technology Will Get You to the Industrial Facility of the Future. . .

Many "tried and true" technologies can be used to reduce your carbon emissions without the need for carbon capture and sequestration.



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Facility Carbon Reduction Strategy

- Facilities are advised to begin the process by developing their baseline carbon position using their MRR data and identifying missing operational and maintenance data (gap analysis).
- Development of a site-specific carbon footprint (~energy balance) is a good first step.
- All of the data gathering is aimed at development of a site-specific Marginal Abatement Curve (MAC).

Baseline Carbon Assessment
↓
Gap Analysis (energy balance, etc.)
↓
Initial Carbon Position
↓
Identification of Potential Reduction Projects
↓
Development of cost estimates
↓
Development of Marginal Abatement Curve (MAC)
↓
Selection of Projects

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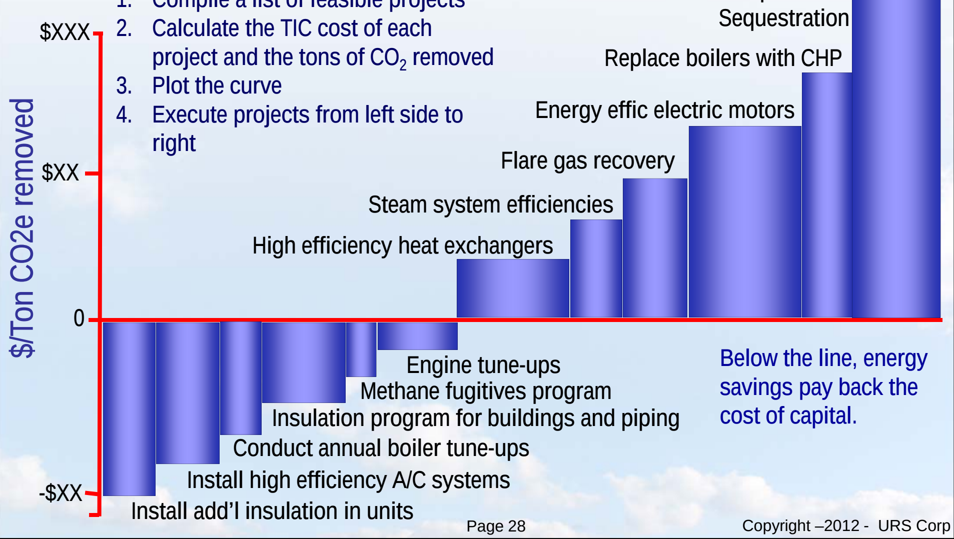
Development of a Site-Specific Marginal Abatement Cost (MAC) Curve

1. Compile a list of feasible projects
2. Calculate the TIC cost of each project and the tons of CO_2 removed
3. Plot the curve
4. Execute projects from left side to right



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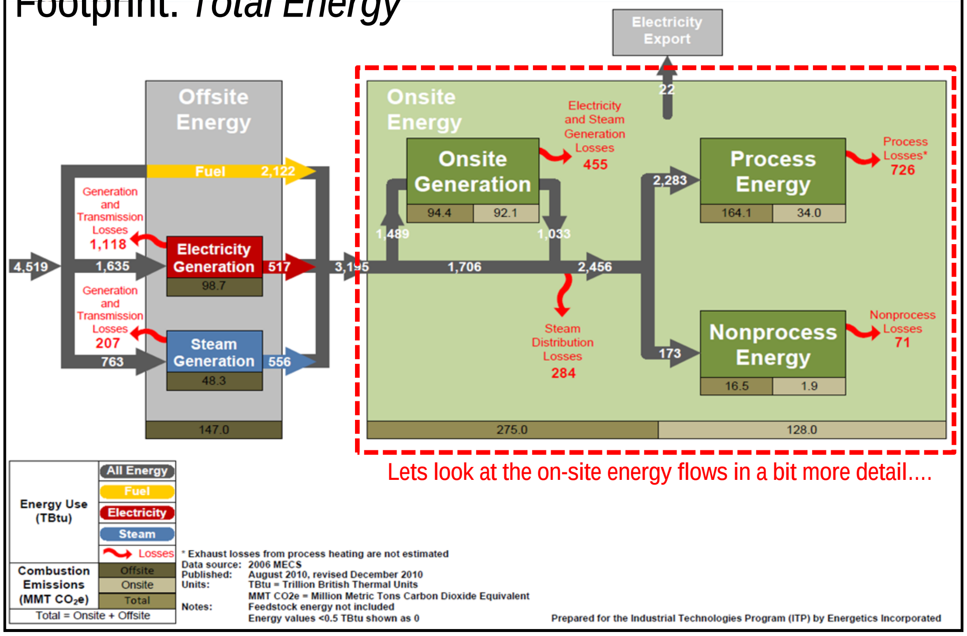
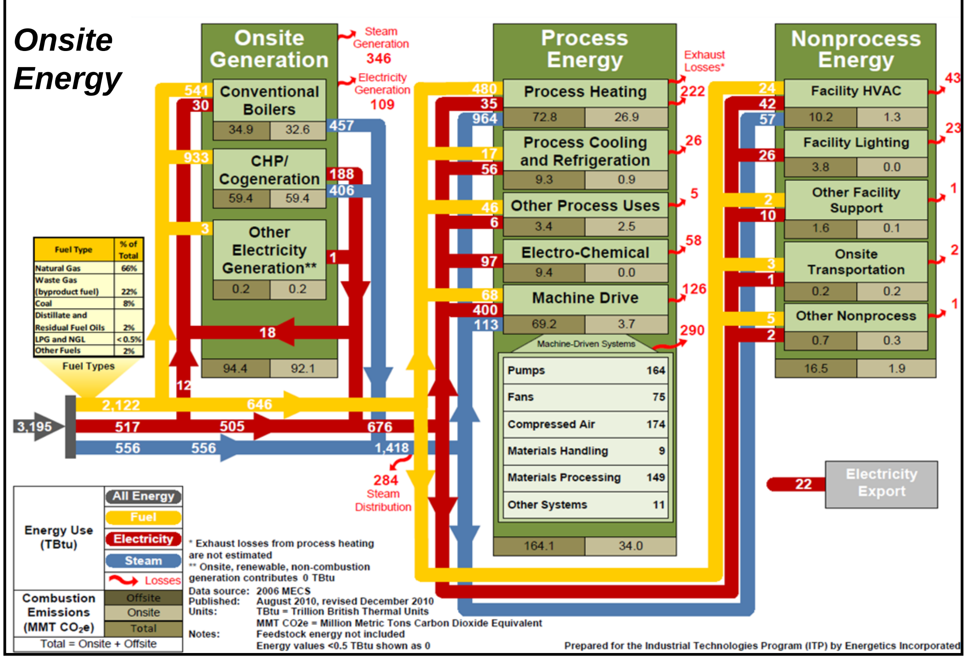
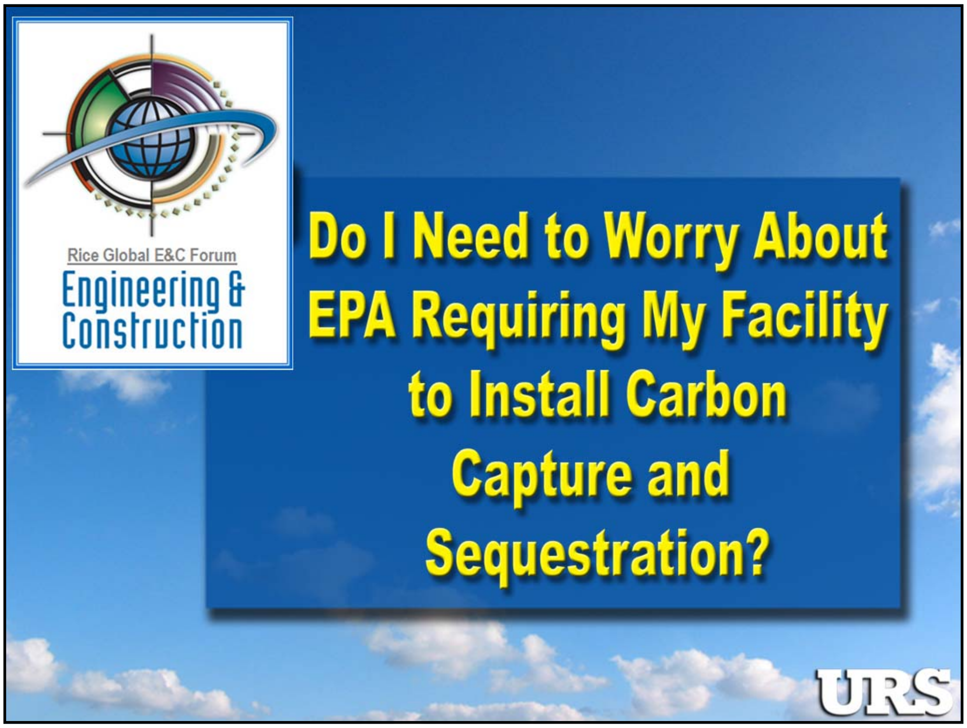
Developing a Site-Specific Chemical Facility Carbon Footprint: *Total Energy*



Developing a Site-Specific Chemical Facility Carbon Footprint

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Do I Need to Worry About EPA Requiring My Facility to Install Carbon Capture and Sequestration?
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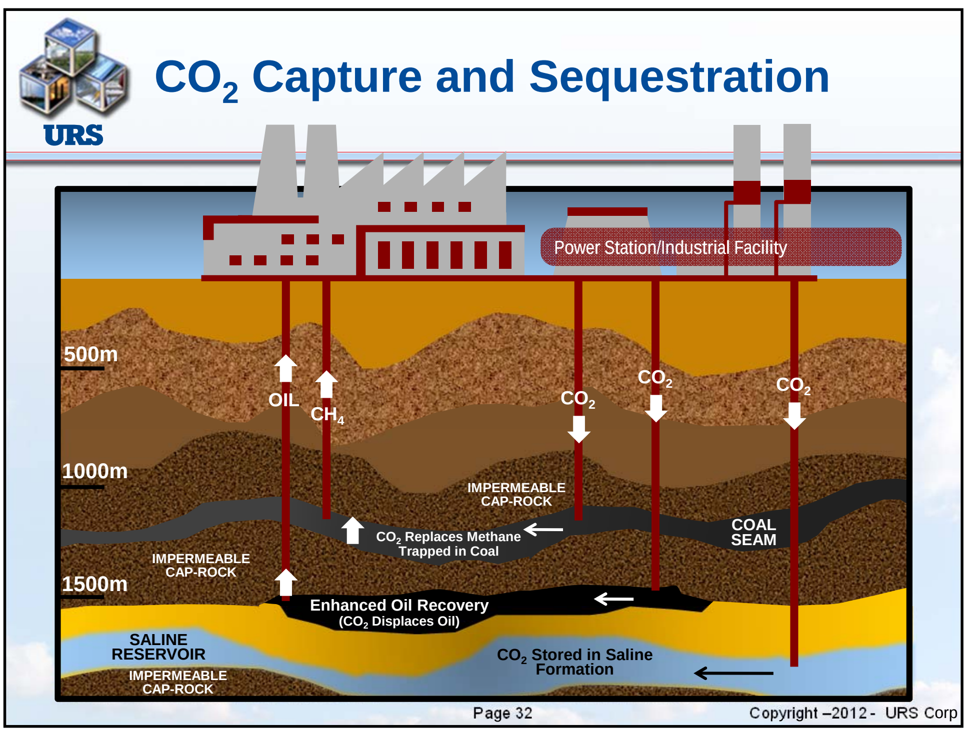
CO2 Capture and Sequestration
URS
Power Station/Industrial Facility
500m
1000m
1500m
OIL
CH4
CO2
CO2
CO2
IMPERMEABLE CAP-ROCK
CO2 Replaces Methane Trapped in Coal
COAL SEAM
IMPERMEABLE CAP-ROCK
Enhanced Oil Recovery
(CO2 Displaces Oil)
SALINE RESERVOIR
IMPERMEABLE CAP-ROCK
CO2 Stored in Saline Formation
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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 CO_2-emitting facilities and industrial facilities with high-purity CO_2 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."

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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 CO_2 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.

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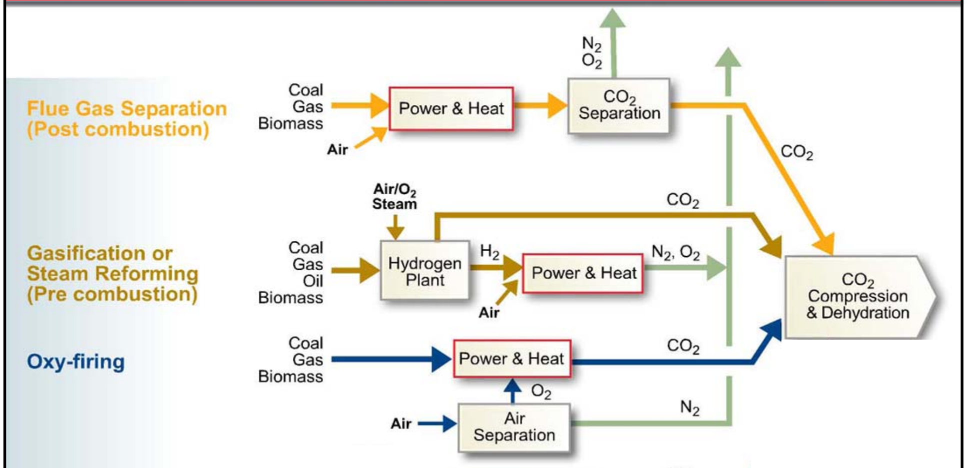
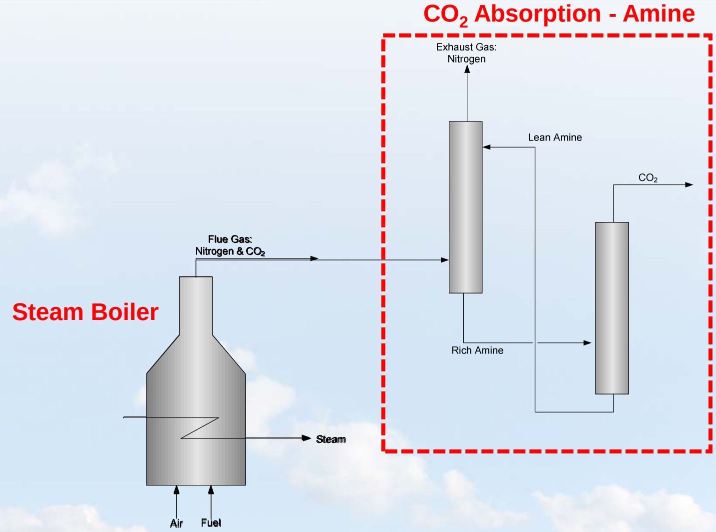
Overview of the Three Primary CO_2 Capture Processes

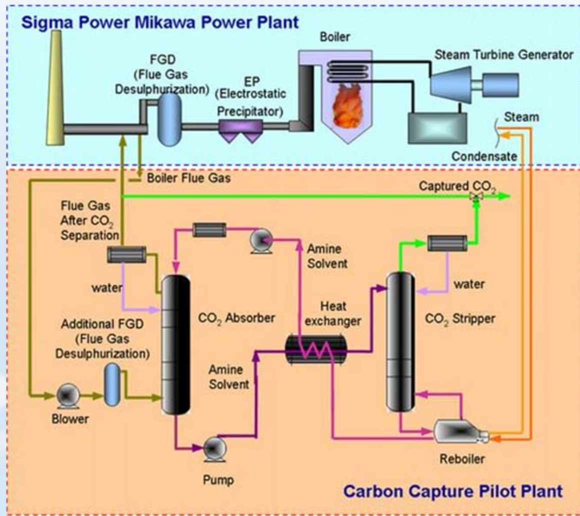


Post-Combustion



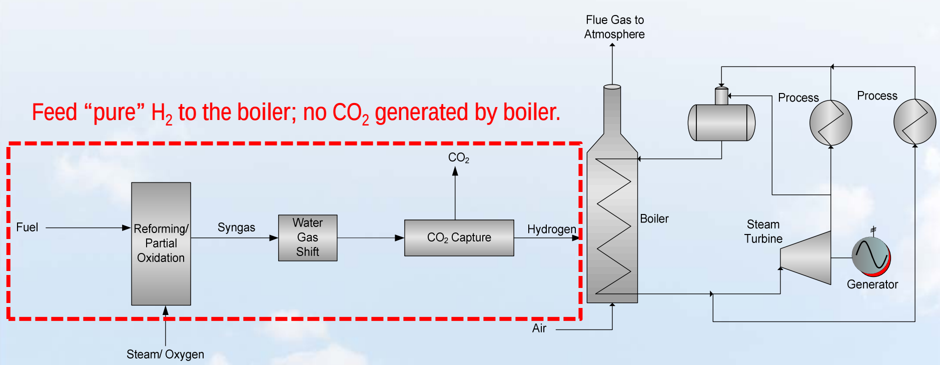
An Example of Post-Combustion CCS System Complexity. . .

A relatively simple coal-fired plant on the top (in green) gets substantially more complex (and significantly less efficient) when CCS is installed (in orange).



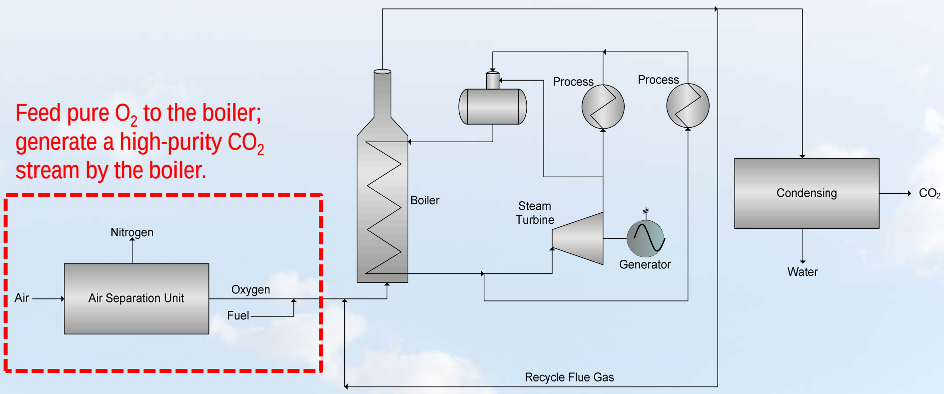
Pre-Combustion

Feed “pure” H_2 to the boiler; no CO_2 generated by boiler.



March 9, 2012

Oxy-Combustion



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Quite a few CO_2 Removal Technologies are Under Development – The Race is On. . .

- CO_2 Removal
  - Absorption
    - Chemical
      - MEA
      - Caustic
      - Other
    - Physical
      - Selexol
      - Rectisol
      - Other
  - Adsorption
    - Adsorber Beds
      - Alumina
      - Zeolite
      - Activated C
    - Regeneration Method
      - Pressure Swing
      - Temperature Swing
      - Washing
  - Cryogenics
  - Membranes
    - Gas Separation
      - Polydimethylsiloxane
      - Polyphenyleneoxide
    - Gas Absorption
      - Polypropelene
    - Ceramic Based Systems
  - Microbial/ Algae Systems

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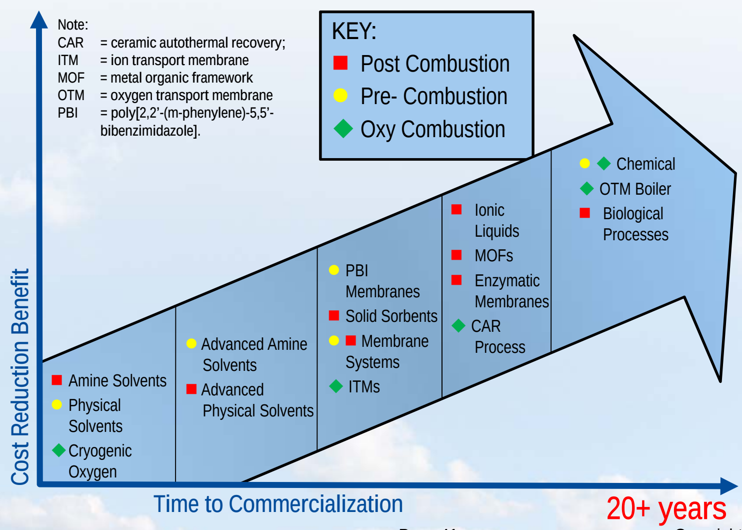
Pre-, Post-Combustion and Oxy-Combustion Technologies – *Time to Commercialization*



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The CO_2 CCS Paradox: Should Decreases in CO_2 Be Required At The Expense of Increases in Other Pollutants?

- CCS technologies are *highly energy-intensive*.
  - CCS will require 20-40% more energy and, in the process, increase emissions of conventional pollutants (NOx, SOx, PM, etc.) by 20-40%.
- Example: CCS applied to an 850 MW coal-fired plant would decrease CO_2 emissions by 6MM Tons/yr (TPY) while increasing emissions of NOx by 400 TPY, SO_2 by 500 TPY, and PM by 300 TPY.
- While "the global community" might benefit, these collateral increases in emissions of conventional pollutants will have well-defined impacts on air quality (and health) in the area surrounding the facility.
- Permitting authorities making BACT determinations for CO_2 emissions will have to weigh these and other adverse impacts against the beneficial impacts they believe will accrue from avoided CO_2 emissions.

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The CCS Paradox (cont'd)

- At the facility in the picture, decreases of GHG at that facility are laudable and will reduce the overall global emissions of CO_2.
- But, the local community around the facility will potentially be subjected to hundreds of tons of higher emissions for SO_2, NO_X, PM and other pollutants due to the parasitic energy costs associated with CCS.

- *Current capture technologies require that we sacrifice the local community for the benefit of the global community.*

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How Can My Facility Avoid Imposition of Carbon Capture?

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Many Facilities Have Avoided Imposition of CCS. . .

- 25+ permits for GHG were issued in the US last year 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?
  - Quite a few different arguments actually
  - Many were unique but some were *quite* unique
  - There were lessons to be learned from all

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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 "bullet-proof" BACT analysis avoiding CCS will focus on those three primary and multiple other secondary arguments, discussed on the following slides.

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Background - BACT CCS Strategies

1. Detrimental to the Environment
   - This should be an easy argument to make!
   - As discussed earlier, there will be significant pollutant emissions associated with the parasitic power 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 20+% add'l pollutant load on the local community is a heavy burden to ask of the locals.

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Background - BACT CCS Strategies (cont'd)

1. Detrimental to the Environment (cont'd)
   - Characterize those emissions resulting from the parasitic load and use them to argue against CCS.
   - Remember, NO_x, SO_2 and PM all have health impacts; CO_2 is something we *EXHALE* and trees love!
   - Determine the local background burden of NO_x, SO_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 doubles with 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.

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Background - BACT CCS Strategies (cont'd)

2. CCS is too costly
   - Eliminating CCS due to cost should be fairly easy, when done right.
   - 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.

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Background - BACT CCS Strategies (cont'd)

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 improved, the economics are typically still very poor.
   - 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.

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Background - BACT CCS Strategies (cont'd)

- 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.

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Background - BACT CCS Strategies (cont'd)

3. CCS is too energy intensive.

- Demonstrate that energy efficient engineering elsewhere within the GTL 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_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, lets change our focus a little bit. . .

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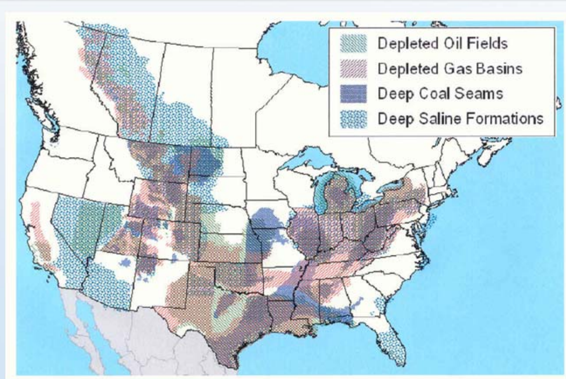
Beyond the Industrial Site. . .

Outside the plant boundary, there is significant add'l CCS uncertainty. . . Lets explore some of those uncertainties. . .

Much of the US has Geological Formations Appropriate for Sequestration

- 60-70% of the US is underlain by geological formations appropriate for long-term sequestration of CO_2.
- But, while there may be a reservoir beneath your facility, it does not mean it is a *suitable/ acceptable* reservoir.



- A potential reservoir must under go 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?
    - LA, MT, ND, and LA will accept liability for the CO_2 after the sequestration site is proven to be suitable/stable.

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Much of the US has Geological Formations Appropriate for Sequestration (cont'd)

- FuturegGen, 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 Ohio?

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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

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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? The pipeline operation may be disrupted for a day or a week. What is your contingency? When the initial term of your contract ends, what options do you have when the reimbursement rate is decreased substantially?

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Permitting Decisions - What Has Transpired in the Last 15 Months?

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Current Status of GHG Permit Submissions

- As of January 1, 2012. . .
  - 150 applications have been submitted that have some form of GHG component
  - 50+ applications submitted include a GHG BACT analysis
- USEPA has submitted comments on 25 applications so far.
  - Those comments can be found at:

    http://www.epa.gov/nsr/ghgcomment.html

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EPA is Treading Softly. . .

As mentioned, at least 25 GHG PSD permits have been issued where EPA offered comments:

- Nucor - A natural gas-fired iron foundry in Louisiana; 1/7/2011
- PacifiCorp - Energy's Lake Side 2 Project: A 629 megawatt combined-cycle expansion of an existing natural gas facility in Utah; 3/4/2011
- WE Energies' biomass-fueled 50 MW power plant in Rothschild, WI; 3/4/2011
- Hyperion Energy Center - 400k bpd greenfield refinery in SD, 4/1/2011
- Abengoa Bioenergy in Kansas – biomass, 4/1/2011
- Mid-American Energy Company - Modifications to an existing coal-fired power plant in Iowa; 5/6/2011
- Wolverine Power Cooperative – A 600 megawatt coal- and biomass-fired power plant in Rogers City, MI, 5/19/2011
- Mackinaw Power – Effingham Power Plant – Add two 180MW combined-cycle turbines in GA, 6/22/2011

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EPA is Treading Softly. . .(cont'd)

- US Steel – Increase taconite production by 3.6 million tpy in Ketac, MN, 6/30/2011
- Cricket Valley's Dover NY Project- A 1000 megawatt combined-cycle power plant, 7/29/2011
- US Nitrogen – Greenfield H_2NO_3, NH_4, and NH_4NO_3 plant – Major source for N_2O (nitrous oxide) emissions in TN, 8/8/2011
- Crawford Renewable Energy – 100 MW Tire-derived-fuel facility in PA, 8/10/2011
- Showa Denko Carbon – Graphite electrode plant expansion in SC, 8/16/2011
- Abengoa Bioenergy in Kansas - biomass, 9/12/2011
- Elizabethtown Energy LLC and Lumberton Energy LLC – Addition of biomass as a fuel to two 215 MM BTU steam boilers in NC, 9/15/2011
- Beaver Wood Energy - biomass and wood pellet (Vermont), 10/17/2011
- Hoosier Energy – 8 coal-bed-methane-fired Reciprocating Internal Combustion Engines (RICE) – in Sullivan, IN, 10/19/2011

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EPA is Treading Softly. . .(cont'd)

- **Kennecott Repowering Project** – Replace 3 coal-fired boilers with one combined-cycle combustion turbine in Magna, UT, 10/27/2011
- **York Plant Holding** - Addition of two simple cycle turbines to existing facility in PA, 11/1/2011
- **Wolverine Power**– Convert simple cycle to combined cycle and add RICE in Belleville, MI, 11/10/2011
- **Universal Cement** - Portland cement plant in Chicago, 11/18/2011
- **U of Wisconsin -Madison** - Add 4 natgas boilers, 12/9/2011
- **Interstate Power and Light (Iowa)**- Ottumwa Generating Station, boiler upgrades, 12/19/2011
- **Christian County Generation** - IGCC in Taylorville, Il., 12/29/2011
- **Indiana Gasification** – New facility to manufacture synthetic natgas and liquid CO_2 from Illinois coal, -02/02/12

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EPA is Treading Softly…But Not for Long!

- USEPA has not had a "heavy foot" in the last year
- 2011 was a year 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.
- This year, USEPA will propose an New Source Performance Standard for utilities and refineries.
  - Any new sources will be required to adhere to the new standards
  - These regs could be very strict – requiring much higher efficiencies than were tolerated by USEPA last year
  - NSPS regs are typically effective on the date they are PROPOSED. Any sources not under construction by the proposal date could be subject.

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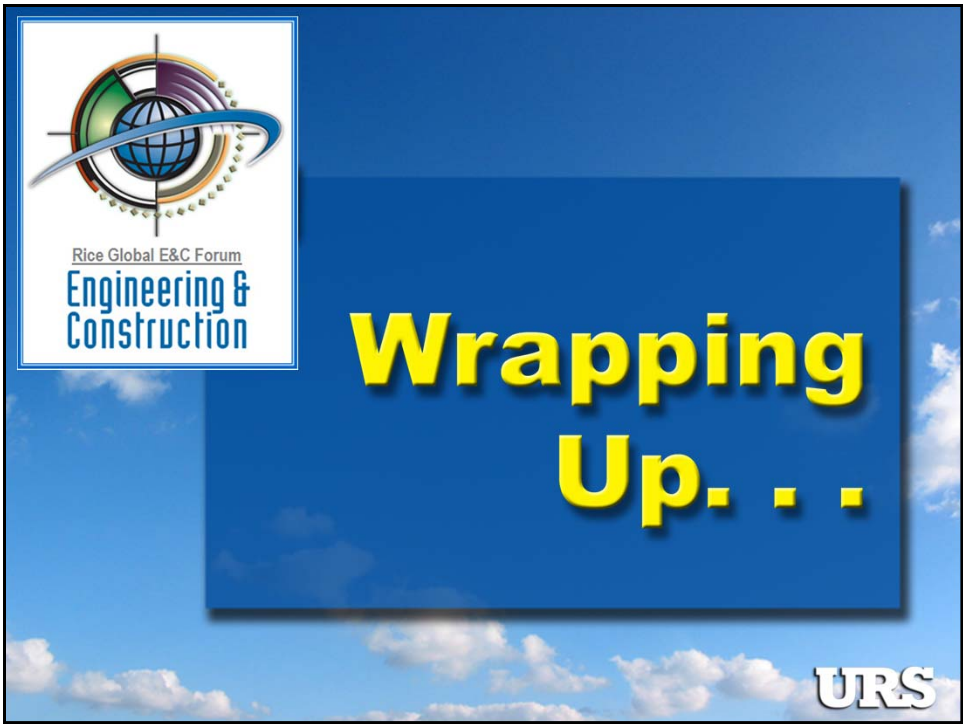

What Can A Facility Do?

- Begin evaluating BACT options now.
  - Identify energy efficiency opportunities
    - Don't forget to survey your electric motors, fans, and pumps that might be big consumers of purchased power (secondary emissions).
  - 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?

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What Can A Facility Do? (cont'd)

- Be careful in these early days not to accept agency requirements for strenuous controls that will, in turn, end up forcing all industry across the nation to adopt those controls.
  - Watch out for output-based efficiency limits like those accepted by Calpine in CA (7,730 BTU/Kwh) because of precedent setting potential. Use the power of industry associations to secure agency consensus on reasonable limitations and/or approaches.
  - Watch out for California – Due to cap/trade, their industrial community has a $20-30/ton incentive to install a higher level of CO_2 controls
- Make sure BACT analyses will pass the "red-faced test" – Is the facility, from an energy *benchmark* standpoint, at least as efficient as other similar facilities permitted in the recent past.

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What Can A Facility Do? (cont'd)

- Plan for more permit challenges than in the past, especially for coal-fired or other solid-fuel-fired facilities
- If you believe that a carbon tax and/or cap/trade will eventually be imposed in the US, consider adopting the practice of many multinationals and applying a "cost" to carbon emissions when calculating internal project economics.
- Work with regulatory agencies to get 365-day averaging periods on any compliance requirements. Any shorter period would be subject to seasonal variations in demand, fuel variability, etc.
  - All compliance parameters given by agencies should be designed with an *operating window, not a set number,* to allow for fuel variability, seasonal variability, and high turn-down ratios.
- Review the carbon content (and variability) of incoming fossil fuels (coal, PRB, petcoke, fuel oils, etc.)

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What Can A Facility Do? (cont'd)

- The state regulator may or may not force you to accept numerical limit
  - Several permits have been issued with no numerical limit for emissions of GHG
  - Agencies have the flexibility not to give you a numerical emissions limit if it can be demonstrated that a numeric limit is *infeasible*.
  - If a regulator forces acceptance of a numerical limit, negotiate a limit equal to the theoretical maximum emissions (PTE) similar to the permit granted by most states last year.
  - Instead of accepting a limit on something hard to monitor like CO_2, consider negotiating a limit on a surrogate like natgas usage that you already monitor.

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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.
  - 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.

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What Can A Facility Do? (cont'd)

- Every permit undergoing USEPA review has asked that a permit condition be added to each permit indicating BACT emission levels must be maintained during all times including startup and shutdown. (This applies to all pollutants.)
  - When negotiating GHG permit conditions, MAKE SURE the facility can attain the efficiency benchmarks even during startup/shutdown.
  - For example, while it may be possible to attain an emissions limit of 7,730 BTU/Kwh while the plant is operating at full capacity, can it attain this same level during startup? Shutdown? Severe turndown ratios? If not, negotiate an acceptable operating window instead of a fixed benchmark rate.
- You will likely face pressure for add-on equipment like air-preheaters to boost efficiency.
  - While those work well at greenfield facilities, there is seldom sufficient space to accommodate an air preheater in many existing, congested facilities.

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What Can A Facility Do? (cont'd)

- USEPA has asked almost every permit to be modified to include a CO_2 CEMS.
  - Instead, negotiate fuel usage monitoring as an alternative to a problem-prone CEMs.
  - Note: A CO_2 CEMS will measure only CO_2 emissions. You are responsible for determining *CO2e* emissions, so all compliance plans must include the other five GHGs, too.
- Include emissions of non-CO_2 constituents – methane and N_20 – 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.
- Be sure to include a separate BACT analysis for all fired sources including even small sources such as fire-water pumps, or be ready to re-do the application.

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What Can A Facility Do? (cont'd)

- 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 and efficiency considerations and enforceable emission limits is important for a proper record to reduce agency comments and intervener objections.
- Thorough analysis of efficiency and technology viability is necessary. For example, it's no longer adequate for peaker power plant applicants to claim that simple-cycle technology is the only available combustion turbine technology. Likewise combined-cycle technology is no longer presumed to be BACT.
- Beware: Unlike end of pipe analysis for traditional PSD pollutants USEPA's focus on efficiency for GHGs may probe into a facility's operations in addition to emission source design/technology efficiency.

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Questions?

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