

Climate Change Business Planning

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Lingo Glossary

- Adaptation
- CCS – Carbon Capture and Storage
- CO₂-Equivalence
- Cap and Trade
- Carbon Footprint
- Direct Emissions
- Geo-Engineering
- GWP – Global Warming Potential (relative to CO₂)
- Indirect Emissions
- Precautionary Principle
- Radiative Efficiency (in W/m²/ppb)
- RPS – Renewal Portfolio Standards
- Sequestration
- Stabilization

Are Regulations Inevitable?

- **Federal Legislation**
 - Lieberman-Warner Climate Stewardship and Innovation Act: Cap-and-trade program, multi-sector, six GHGs, reductions to 1990 levels by 2020
 - Bingaman Climate and Economy Insurance Act: Includes “high-GWP gases”
- **Regional Greenhouse Gas Initiative**
 - 9 Northeast and Mid-Atlantic states designing cap and trade program
 - Starting with power plants January 1, 2009, but will later expand to other industries
 - Preparing to launch the first-in-the nation auction of carbon dioxide (CO₂) allowances
- **California**
 - Vehicle Emissions Standards
 - Assembly Bill 32: Goal of 25% emissions reductions by 2020, Targets “significant” sources, including for semiconductor industry PFCs
 - Public Utilities and Energy Commissions: Implementing regulations setting CO₂ emissions performance standards for power plants
 - Regional Reduction Agreement with Arizona, New Mexico, Oregon and Washington

Are Regulations Inevitable?

- **Renewable Portfolio Standards**
 - Even Texas has goals for “wind, geothermal, hydroelectric, wave, or tidal energy, or on biomass or biomass-based waste products, including landfill gas”
- **Energy Company CEOs**
 - Accepting science, desire uniform Federal regulatory approach
 - Promoting cap and trade or emissions tax
 - (See www.washingtonpost.com, November 25, 2006)
- **Wal-Mart**
 - Goal to use 100% renewable energy
- **US Supreme Court Case**
 - Massachusetts vs. EPA: Ruled 5 to 4 on April 2, 2007 that the EPA has the authority to regulate greenhouse gases in automobile exhaust
 - EPA must protect public welfare unless it makes a scientific determination that GHGs do not contribute to climate change
 - Advance Notice of Proposed Rulemaking issued July 11, 2008

Precautionary Principle in Action

**All of the Domestic Initiatives are
Independent of Kyoto Protocol!**



Assessing Risk

- Start by calculating greenhouse gas emissions baseline
- Combustion Emissions – CO₂, CH₄, N₂O
 - Boilers
 - Generators
 - Fire Pumps
 - Solvent Abatement
- Process Emissions - N₂O, NF₃, SF₆, PFC and HFC
 - Diffusion, CVD (Passivation) - N₂O
 - Etch – process gases
 - NF₃, SF₆, C₄F₈, CF₄, C₂F₆, C₃F₈, CHF₃
 - CVD – clean gases
 - NF₃, C₂F₆, CF₄
 - Process Equipment Chiller Units
 - Fluorinated Heat Transfer Fluids
- Indirect Emissions – CO₂, CH₄, N₂O
 - Electricity Use

Assessing Risk – Combustion Calculations

- 2006 IPCC Guidance for National Greenhouse Gas Inventories
 - Available at <http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm>
 - Volume 2 Stationary Combustion
 - Results in emissions for CO₂, N₂O and CH₄
- Or, in US, Use AP 42, Fifth Edition, Volume I
 - Boilers: Chapter 1: External Combustion Sources
 - Generators, Fire Pumps and Oxidizers: Chapter 3: Stationary Internal Combustion Sources

Assessing Risk – PFC Calculations

- 2006 IPCC Guidance for National Greenhouse Gas Inventories
 - Volume 6 Electronic Industry Emissions (formerly PFC, HFC, SF6 Emissions from Semiconductor Manufacturing)
 - Typically use Tier 2a, 2b or 3 methods – require site specific gas consumption and emissions control efficiencies
 - Results in emissions for CF₄, C₂F₆, CHF₃, C₃F₈, C₄F₆, C₄F₈, C₄F₈O, C₅F₈, C₆F₁₄, NF₃, SF₆ and by-products from F₂ and COF₂

Assessing Risk – PFC Calculations

EQUATION 6.2

TIER 2a METHOD FOR ESTIMATION OF FC EMISSIONS

$$E_i = (1 - h) \cdot FC_i \cdot (1 - U_i) \cdot (1 - a_i \cdot d_i)$$

Where:

E_i = emissions of gas i , kg

FC_i = consumption of gas i , (e.g., CF_4 , C_2F_6 , C_3F_8 , $c-C_4F_8$, $c-C_4F_8O$, C_4F_6 , C_5F_8 , CHF_3 , CH_2F_2 , NF_3 , SF_6), kg

h = fraction of gas remaining in shipping container (heel) after use, fraction

U_i = use rate of gas i (fraction destroyed or transformed in process), fraction

a_i = fraction of gas i volume used in processes with emission control technologies (company- or plant-specific), fraction

d_i = fraction of gas i destroyed by the emission control technology, fraction

- From IPCC Guidance for National Greenhouse Gas Inventories
- Also similar equations available for CF_4 and C_2F_6 by-products emissions

Assessing Risk – Electricity Calculations

Emissions from purchased electricity

Emitted GHG	Emission Factor (kg/kWh)
CO ₂	0.63
CH ₄	5x10 ⁻⁶
N ₂ O	9x10 ⁻⁶

- Above Per US EPA Clean Energy Site
- Also reportedly available from EMEP/CORINAIR Emission Inventory Guidebook

Assessing Risk - Conversion to Carbon - Equivalent

$$MMTCE = \sum_i^7 \frac{Q_i(GWP_{100})_i}{10^9} \left(\frac{12}{44} \right)$$

Q_i = the quantity of GHG_i released
in kg (from IPCC algorithms)

$(GWP_{100})_i$ = the equivalent CO₂
mass with same radiative efficiency
for GHG_i integrated over a 100 year
time horizon (Accounts for time and
wavelengths of absorbance effects.)

MMT(CO₂)E = same equation as
above without conversion from CO₂
to C (12/44)

Compound	Lifetime	GWP ₁₀₀
Carbon Dioxide	variable	1
Methane	8.4/12	23
Nitrous Oxide	120/114	296
Select HFC, PFC and SF	6	
CHF ₃	260	12000
CF ₄	>50000	5700
C ₂ F ₆	10000	11900
C ₃ F ₈	2600	8600
c-C ₄ F ₈	3200	10000
NF ₃	>500	10800
SF ₆	3200	22200

Source: IPCC TAR

GWP₁₀₀ = Global Warming Potential, 100 year time horizon
GHG = Greenhouse Gas



Assessing Risk – Project Future Emissions

- Any planned expansions of overall facilities?
 - New combustion sources?
 - Increased electricity usage?
- Any planned process expansion or change?
 - Increases in process emissions?
- Estimate annual change in MMT(CO₂)E

Reducing Risk

- Based upon project future emissions, will you be a purchaser or generator of MM(CO₂)E credits under cap and trade program?
 - Chicago Climate Exchange (CCX) at \$4.15/MMT(CO₂)E
- Assess options for reducing emissions/increasing credits
 - Combustion
 - HVAC Optimization
 - Oxidizer Temperature Evaluation
 - In-Direct
 - Energy/electricity reductions through equipment replacement and optimization
 - Process
 - Process optimization
 - Chemical Replacement
 - Abatement
 - Are third party offset reductions (i.e. CDMs), renewable energy or capture and storage (i.e. sequestration) viable options?

Reducing Corporate Risk

- Involve stakeholders (facilities, process, management) in preparing a GHG Business Plan
 - Track Policy Developments, Including MACT/NSPS Type Controls and RPS
 - Conduct a Baseline Inventory and Project Future
 - Evaluate Voluntary Program Participation
 - Prepare for Adaptation of Business
 - Set Corporate “Targets and Timetables” for Reduction of “Carbon Footprint”

Assessing Business Opportunities

- Consider Opportunities to Profit
 - Sell Credits or CDMs
 - Produce Renewable Energy
 - Produce Infrastructure
 - Photovoltaic Systems
 - Wind Turbines
 - Participate in Carbon Capture and Storage
 - Build Pipelines
 - Own Repositories
- Position Existing Products as “Green”, “Carbon Neutral”, etc.
 - R&D for New Green Products
- National Cap-and-Trade Will Result in a New Economy
 - EPA’s Climate Change Credit Corporation Is Projected to Handle \$6.7 trillion from 2012 to 2050

What Can an Individual Do?

- Seven Ways an Individual Can Slow Global Warming
 1. Choose green power
 2. Be fuel-efficient
 3. Choose energy saving appliances
 4. Reduce, reuse, recycle
 5. Be water wise
 6. Compute (see EPA's Personal Emissions Calculator)
 7. Explore and enjoy your nearby world

Ref: Natural Resources Defense Council, www.nrdc.org

