

Climate Change Business Planning

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“Green House Gas Management and Emissions Reporting”



Lingo Glossary

- Adaptation
- CCS – Carbon Capture and Storage
- CO₂-Equivalence
- Cap and Trade
- Carbon Footprint
- Direct Emissions
- Geo-Engineering
- GWP – Global Warming Potential
- Indirect Emissions
- Precautionary Principle
- Radiative Efficiency
- RPS – Renewal Portfolio Standards
- Sequestration
- Stabilization

Are Regulations Inevitable?

- **Federal Legislation**
 - McCain-Lieberman 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**
 - 7 Northeast and Mid-Atlantic states designing cap and trade program
 - Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont plus Maryland on June 30
 - District of Columbia , Massachusetts, Pennsylvania, Rhode Island, the Eastern Canadian Provinces, and New Brunswick are observers in the process
 - Starts with power plants January 1, 2009, but will later expand to other industries
- **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
 - Boosts California's prospects for gaining EPA approval of its own program to limit tailpipe emissions of greenhouse gases – reduce 30% by 2016

Precautionary Principle in Action

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

**And then there's the ever more important issues
of eco-friendly and socially responsible investing
in the stock market. See Innovest ratings.**



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

Note: May already be reporting PFCs to SIA for EPA MOU supporting WSC agreement for 10% reduction from 1995

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 CO₂-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)

(GWP₁₀₀)_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
 - Plasma remote clean
 - 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 Climate Change 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”
- Even if you don’t prepare a plan now, it’s past time to start keeping records
 - Energy usage, process chemical usage
 - Identify and defensibly quantify all reductions through time
 - Go back as far as possible

What Can an Individual Do?

- Seven Ways an Individual Can Slow Global Warming
 1. Choose green power
 2. Be fuel-efficient, buy local products, and shop and bank on-line
 3. Choose energy saving appliances, unplug appliances and change to fluorescent bulbs
 4. Reduce, reuse, recycle
 5. Be water wise, filter water rather than buy bottled
 6. Minimize travel, telecommute and vacation closer to home
 7. Compute (see EPA's Personal Emissions Calculator)

Ref: Natural Resources Defense Council, www.nrdc.org
and "Save a Buck, Save the World", CNNMoney.com