Implementing a Climate Change Program

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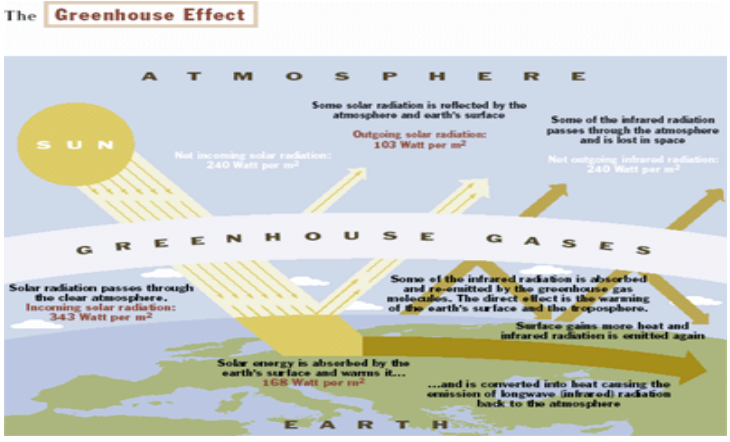
BACKGROUND

Climate Change is a major buzzword in the media, among politicians, and the public these days. The findings of a number of scientific panels reviewing thousands of scientific articles shows that many current physical disasters we are seeing globally is at least partially attributed to climate change, making this a major issue. People across the globe have expressed concern and are demanding that governments address this issue. Besides government regulations impacting industries, but new technologies will allow people to maintain their lifestyles while reducing greenhouse gas emissions. In both respects, it is the engineer that must lead the way to make progress.

What is causing this change in our climate? There is now virtual unanimity in the scientific community that at least a significant portion of the problem is related to significant increases in greenhouse gas (GHG) emissions from manmade sources in the past century. GHGs are a group of compounds found in the atmosphere and are capable of absorbing infrared radiation emanating from the earth's surface. These rays would normally travel through the atmosphere and subsequently to outer space. See Figure 1 below for an illustration. There has always been a balance between losing the radiation and keeping the energy in the atmosphere given the long-term stable levels of these compounds. However, atmospheric concentrations of GHGs have risen by about 50% in the last 140 years, in parallel with the industrial revolution and the proliferation of combustion of fossil fuels, the automobile and the global temperature rise.

Figure 1 - Illustration of the Greenhouse Effect

from the Pew Center on Global Climate



THE RESPONSE TO CLIMATE CHANGE IN THE U.S.

Given the global nature of the climate change problem, global agreements have attempted to find a global solution through the Kyoto Protocol, which went into effect in 2005 and, currently, the Paris Climate Agreement. There are currently no federal rules pertaining to GHG emissions, although some state and regional rules have gone into effect.

Many forward-thinking U.S. firms are developing climate change programs, as they recognize that this as not just another environmental compliance program, but a unique program with core business values that will benefit any firm. These firms recognize the cost savings from energy reductions, the possibility of qualifying for sellable credits, the evaluation and reduction of different climate change risks, and the relationship between climate change and corporate image and product development.

Climate change is a core business area, beyond just Environment, Health & Safety (EH&S). Other departments influenced by climate change are Manufacturing, Engineering, Energy, Legal, Communications, Financial, Risk Analysis, Product Development, and Operations. Decisions concerning climate change will impact these departments. Here are eight ways a robust climate change program will benefit the bottom line of a firm, not just another compliance program.

1. Reduce Expenses and Make Money

Climate change can become a catalyst for reducing significant expenses. Reducing GHG emissions most commonly occurs by reducing fossil fuel combustion and electricity usage. Given the high price of fuel and electricity these days, such projects will also result in significant cost savings. Just as important, a long-term reduction of fuel use will cushion your company from sudden spikes in energy costs and shortages that have occurred in recent years and will occur in the future. Expense stability is a major issue for companies. While an energy audit for many firms may not be a high priority item, the teaming of this with significant GHG emission reductions may make it a higher priority.

In addition, verified reductions of GHG emissions can result in credits that your firm can own and sell on the market for revenue. In the U.S., this would occur on the voluntary market. In other countries, projects resulting in GHG emission reductions could be tied to Clean Development Mechanism (CDM) and other programs through the Kyoto Protocol.

2. Create New Products and Sell More

Studies have shown that a growing number of global consumers are using the environmental perception of a company or product as a factor in making purchasing decisions. Some evidence exists that U.S. consumers are moving in this direction too. Therefore, many companies are marketing to demonstrate how "green" they or their products are. A consumer backlash on what is "environmentally friendly" plus Federal Trade Commission rules concerning "green" claims, means that a company must be careful in what it claims. Claims must be truthful and specific. An advantage of a climate change program is its specificity for measuring environmental progress. If a company can demonstrate a reduction in GHG emissions of a certain percentage or quantity, then the

company can undeniably demonstrate something positive for the environment. Therefore, a climate change program can provide verifiable data to help sell your products more effectively, adding to the bottom line.

Like any new business opportunity, climate change offers possibilities to firms that are open to new ideas. Toyota with its Prius and GE with its Ecomagination program are examples of firms using the recognition and demand of climate change to produce and market products. Ecomagination is merely the repackaging of existing GE products showing off their positive environmental impacts. Sales of these products doubled to $20 billion in a short period once they were repackaged as environmentally friendly.

3. Impress Customers and Suppliers

Some companies are now requiring their suppliers to provide specific information about the GHG emissions of their products along with the product life cycle. For example, Tesco, the UK's largest retailer, attaches a GHG "label" to every product it sells, allowing customers to compare products in terms of the GHG emissions. Therefore, a climate change program resulting in reductions of or minimization of GHG emissions will likely help in the selling of products.

In addition, some companies are requiring their suppliers to implement minimum energy or other GHG minimizing practices as a condition of purchase. Implementing a systematic climate change program and successfully minimizing GHG emissions will show your customers and suppliers that your company is being proactive, and consequently, gain a competitive edge.

4. Raise Employee Morale

Employee morale and longevity are recognized as critical issues for continued company success in a competitive market. The cost of lost productivity and finding and training the replacement of a valued employee is quite high to companies. While reducing turnover and having a motivated workforce seem like peripheral business factors, these items influence both short-term bottom line and long-term growth.

Companies have reported that in many cases their employees have a new zeal and devotion to the workplace once they have realized that their employer has invested in or become aware of corporate climate change and sustainability programs. Employees of such companies have come to believe that their employer is dedicated to a greater good, and consequently, have become more loyal and productive workers.

In addition, a number of recent studies have shown that implementing building upgrades to meet Leadership in Energy and Environmental Design (LEED) standards from the US Green Building Council (USGBC) will likely result in an increase in productivity and reduction in sick days, good for both the company bottom line and employee satisfaction.

5. Fast-track Future Projects

Company environmental programs can help defuse conflicts with advocacy groups. One example was the purchase of power plants from TXU in Texas. The buyer wanted to

expand power production to help a growing region and proposed expanding some of the TXU power plants, including combusting coal in the short=term. The buyers proposed a climate change program for increased production, yet no net increase in GHG emissions. This was a major factor in the approval by environmental groups of the proposed expansion, including construction of new coal-fired power plants. These environmental groups agreed to support this expansion because of the assurance that a robust, long-term climate change program would be in place with distinct, measurable goals.

6. Improve Efficiency

A climate change program with GHG emissions reduction targets can best be achieved by improving operational efficiency throughout a firm's general business. This can be achieved by evaluating the entire product cycle, from the handling of raw materials to transportation of raw materials to the plant to delivery of the product to the customers, as well as evaluating the actual manufacturing process. While many companies say they are in favor of improved efficiency, these programs and activities are often set aside to achieve other short-term goals. Climate change and achieving GHG emission reductions can be used as the catalyst for such programs which will benefit the long-term health of the company.

7. Evaluate Climate Risks

The majority of scientists in the field globally has forecast many potential grave dangers associated with climate change, such as rising global temperatures, rising sea levels, more frequent and violent storms, and severe draughts. How would these physical impacts affect the way you conduct business should some of these dangers manifest themselves? For example, if your company operates a critical manufacturing plant on an island, how would your bottom line be impacted by the purported greater risk of being severely damaged by a major storm? What if you don't even own that plant, but depend on a raw material it produces? Should greater flooding and storms occur, how would that affect your transportation systems, moving products around the world?

In addition, what are the financial risks revolving around climate change? What would be the long-term effects of hotter weather, more people afflicted with tropical diseases, and long-term water shortages on people's standards of living and consumer confidence in your products?

Finally, there are dynamic changes ahead in terms of climate change regulations.

A climate change risk program can delve deeper into questions involving these physical, financial, and regulatory risks and allow your company to be prepared early in the process to make the proper investments to minimize these risks and even turn risk into opportunities. Also, evaluating and mitigating risks will help you meet SEC and other disclosure requirements to your shareholders and appeasing them, as many of them are expressing concerns about climate change at shareholder meetings.

8. Prepare for Regulation

The Paris Climate Agreement globally and the Inflation Reduction Act in the US are

examples of greater recognition of climate change's effects and impacts. While there is partisan bickering in the U.S., some cities and states have promulgated their own climate change rules, and these are likely to grow as many have achieved success.

Having a climate change program will put your company in a better position to prepare for any future international and federal rules that may impact you. This will save your company costs to prepare for compliance and can be used as an opportunity to prosper over your competitors. In addition, with your own climate change program, your firm will be in a better position to advocate for rules that reward your prior efforts in a greater way.

INITIATING A CLIMATE CHANGE PROGRAM

So you have decided to establish a Climate Change program. Some think that that is great and let's go out to the buildings and record data. No. There are critical steps to take to set up your Climate Change program to better ensure success. Here are some of them.

1. Establish a Climate Change Infrastructure

A climate change program established by one person or one department is unlikely to succeed because of the many business areas (discussed above) that are influenced by climate change. If decisions are made without the cooperation of many or all of these groups, then opportunities for gain will be lost.

A committee or group should be formed to plan, implement, and monitor a climate change program. Participants should include representatives from diverse groups influenced by climate change, such as Environmental, Health & Safety Operations, Engineering, Legal, Risk Analysis, Finance, Communications, Product Development, and others. Of course, in the real world it is difficult to get representatives of such groups to even get together, or to agree on a direction and course of action. To get these diverse groups to work together, leadership from the top – even at the CEO level - is critical. Such leadership needs to demand concrete actions and progress reports by the group within reasonable dates.

It is important when getting started to develop and record the overall strategy of the group. First, the group needs to document which factors were most important in deciding to implement a climate change strategy and corresponding goals: Potential energy savings? Potential revenue stream? Preparing for future regulations? Responding to internal or external queries? Enhancing your company's image? Which of these factors are most important to the company leaders or crucial stakeholders?

Another important matter to decide is the ultimate, long-term goal of the climate change program and what your company's level of commitment may be. Will your firm be a leader in your industry? Or will your firm be "in the middle of the pack"? Or perhaps will it be a follower? There is no "right or wrong" about this. You need to understand your

firm's potential for success: available resources, its commitment and will to be applied to climate change, and anticipate the long term goals.

Next, it is important to anticipate the various elements of a climate change program and the ability of your company to perform the necessary activities to make it successful. It is important to plan and anticipate which program elements (discussed later) will be easier or harder to achieve based on company culture and available resources. Such an effort better ensures the success of the program and will save the company money and time.

Diagnostic tools exist to help companies quantify exactly which elements of climate change will be easier to implement successfully and which will be more difficult to assist in planning. The best approach is to have diverse company officials answer questions concerning the new climate change program and the various future stages. Answers will indicate which elements will be easier or harder to implement.

HOW TO IMPLEMENT A BASELINE GHG EMISSIONS INVENTORY

Once careful planning for a climate change program is completed, the next step is to develop a baseline GHG emissions inventory of the various direct and indirect sources at your facilities. Why is such a step necessary? Because one cannot manage your climate change program through GHG emission reductions without first measuring and understanding their nature.

The first step is to develop the right approach and "boundary". Which processes will you evaluate and which ones (which may emit GHG emissions) will you not include in the inventory? The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) has developed nomenclature to define the boundary.

- Scope 1 emissions are direct GHG emissions from your processes and facilities. These generally include fuel combustion equipment (i.e., boilers, electricity generators) and mobile sources (i.e., company-owned automobiles, trucks, etc.)
- Scope 2 emissions are indirect GHG emissions caused by your operations, such as purchased electricity and steam. While connecting a plug in an electric outlet does not cause GHG emissions at at facility, it does cause another facility (a power plant) to potentially combust fuel causing GHGs to be emitted to generate that electricity or steam.
- Scope 3 emissions are other indirect GHG emissions, mainly caused by the actions of other firms not directly under your control but involved in making your product. These include such items as GHG emissions from the production of raw materials requested by your facilities, transportation of the raw materials to your facilities, delivery of the finished products to warehouses or stores, services that are contracted out to other firms, business travel, and others.

It ultimately may be more cost-effective for your company to evaluate and reduce GHG emissions from sources related to your business but out of your control, such as supply

lines, customer end use, waste handling, and outsourcing activities. This is called a Life Cycle Analysis (LCA) and will be discussed later.

Typically, once the boundary is established, the GHG emissions inventory begins with an appropriate request for information necessary to perform the emission calculations. Such an information request can be done electronically by a database completed by facility managers remotely from their desks or can be done by paper or Excel spreadsheet. The various facility managers complete the questionnaire and submit it back for compilation and calculation of GHG emissions.

Data necessary for the major portions of a typical GHG emissions inventory are as follows:

- fuel usage for stationary sources (i.e., electricity generators, boilers)
- electricity purchases (usage)
- steam purchases (usage)
- usage of mobile sources (distance travelled or gasoline/diesel usage of company-owned automobiles, buses, trucks, airplanes, etc.)
- replacement levels of refrigerants (considered equal to what has leaked and, thus, emitted into the atmosphere)
- number of trips and miles spent in business travel

The most critical part of any GHG emissions inventory is data quality, as often raw data is not complete or accurate or the data entry person is unsure of how to interpret something or simply clicks the wrong box in the questionnaire. Although it appears that parameters like electricity and fuel usages are fairly simple (such as reading it off a bill or meter), it is usually not that simple. Does the electricity or fuel usage cover all processes? Are other processes captured in other bills or documentation? Are there multiple suppliers and therefore bills? Are they comparable? Are the correct units incorporated in data entry and emission calculations or are they mixed between facilities?

Given that major decisions and investments may ride on the inventory, it is critical to devote significant resources to performing QA/QC on the data collected. Third-party verification is recommended, including at least spot reviews of the raw data from representative facilities. For entry into some programs, third-party verification is required. Again, data must be complete, accurate, and transparent. It is generally a good idea to send a followup questionnaire investigating the nature of the raw data.

GHG emission estimations are generally straightforward. Emission factors are generally used. The WRI/WBCSD "GHG Protocol" contains specific emission factors for many different situations, such as combustion of different fuels from different types of equipment. The GHG Protocol also contains country-specific factors for electricity production based on the degree of usage of different fuels or non-combustion sources of electricity (i.e., nuclear, solar, wind, etc.). In addition, the U.S. Dept of Energy (USDOE) has region-specific GHG emission factors in the U.S., depending also on the average

degree of fuel use in that region (coal, oil, natural gas, nuclear, renewable). These factors are updated often, even annually, enabling them to be up to date.

Electricity or fuel usage multiplied by the appropriate GHG emission factor will determine GHG emissions. Because climate change programs have originated and greatly developed in Europe and Japan, most GHG emissions are expressed in metric units, such as kilograms (kg) or metric tons (tonnes). Therefore, many voluntary programs in the U.S. express GHG emissions and reductions in metric units, as well.

While CO_2 is the most common GHG, there are a total of six recognized GHGs, including methane (CH_4), N_2O, HFCs, CFCs, and sulfur hexafluoride (SF_6). Each compound or compound within a class has a different "global warming potential". According to the UN's Intergovernmental Panel on Climate Change (IPCC) report in 2001, here are the global warming potentials (GWP) for the common GHGs.

Gas	New GWP*
Carbon Dioxide (CO2)	1
Methane (CH4)	23
Nitrous Oxide (N2O)	296
HFC-23	12,000
HFC-125	3,400
HFC-134a	1,300
HFC-152a	120
HFC-227ea	3,500
Perfluoromethane (CF_4)	5,700
Perfluoroethane (C_2F_6)	11,900
Sulfur Hexafluoride (SF_6)	22,200

*Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis*, Cambridge University Press, 2001, Table 3, p. 47.

These factors should be used in GHG emission calculations. For example, reducing 1 tonne of CH_4 is equivalent to reducing 23 tonnes of CO_2. In fact, reducing 1 pound of SF_6 is equivalent to reducing 11.1 short tons of CO_2.

Therefore, when compiling an inventory of total company GHG emissions one should take global warming potentials into consideration, developing an emission rate called CO_2 equivalents or "CO_2e". For example, a company determines that its Scope 1 emissions for a given year equal 45,000 tonnes CO_2, 945 tonnes CH_4, and 20 tonnes of N_2O, based on emission factors for their boilers for their particular fuels that cover these three GHGs. Its total Scope 1 GHG emissions would be (45,000 x 1) + (945 x 23) + (20 x 296) = 72,655 tonnes CO_2e. Although the mass rates of CH_4 and N_2O are much lower than CO_2, the GHG emissions given their high global warming potentials are nearly as high as CO_2's.

In addition, from a strategic point of view, each GHG's global warming potential introduces a different approach for emission reductions. It may be more cost effective for a company to reduce 1 tonne of CH_4 than 23 tonnes of CO_2 or 1 pound of SF_6 compared to 11.1 short tons of CO_2. This can give the company more options to cost-effectively reduce GHG emissions to address Climate Change.

While GHG emissions are commonly reported in a mass unit per year as discussed above, this is limiting as it is difficult to compare facilities, divisions, or processes. GHG emissions can also be useful if normalized to an appropriate activity, such as kg CO_2e per tonne of chemical produced, kg per sq.m. of office space, kg per $ revenue, kg per KWh electricity produced or used. This allows easier facility to facility comparisons and allows the company to better strategize on areas for effective potential efficiency improvements. Such a calculation, therefore, is dependent on selecting the appropriate activity to normalize to and on obtaining the appropriate quality data covering the same period as GHG emissions.

It is important for a company to invest in an efficient GHG data management system in the long term. While an Excel spreadsheet may be sufficient for an initial inventory, when data is collected over several years and accounting for changes and growth and new facilities and processes, an Excel spreadsheet may become a liability. Based on the growth of climate change programs worldwide in response to the Kyoto Protocol, a number of firms have developed software specific for GHG data management. It is advantageous for a company to research and invest in such software for a long-term climate change program to save it time and money in terms of data management.

Typically, a GHG software evaluation begins with a needs assessment. What are the unique needs that a company's climate change program has that must be addressed by the software? How can the software correspond to the company's climate change goals? What are the company's current environmental and business software systems? How does climate change interact with these systems? Can the new GHG software "communicate" with these existing systems? Can the climate change needs identified above be incorporated into existing company software?

A professional assessment and recommendations for software to manage GHG data and "communicate" to existing environmental and business software are critical. Three potential options to choose from in terms of cost and operationally effectiveness include:

- modify existing software to meet future climate change needs;
- purchase an existing specific commercially-available GHG data management system with incorporation of changes to the code by the vendor to meet company-specific needs; or
- develop GHG management software from "scratch".

CARBON FOOTPRINTING

An exercise that is similar to a baseline GHG emissions inventory, but is more involved, is something called a "carbon footprint". Carbon, as better understood by the public, is short euphemism for GHGs. The "footprint" represents the "permanent" mark left by the company (in terms of carbon emissions) from activities related to its being and its products, including activities that it does not directly control.

The baseline GHG emissions inventory discussed above focuses on activities that the company controls, such as manufacturing and transportation of product to warehouses or retail stores. However, the life cycle of a product that a company manufactures includes many additional steps from which GHGs may be emitted and represents opportunities for more cost effective emission reductions. A life cycle analysis (LCA) is an estimation of GHG emissions from each step in the life cycle of a product. Think about a typical product you have right now (the shirt you are wearing, the laptop or smart phone on which you are reading this, a pen, a cup of coffee or juice) and think about the steps of that product's life cycle including:

- **Creation of "capital goods".** The building of the factories, roads, equipment, and remaining infrastructure that allows manufacturing of the product is an activity that could potentially result in GHG emissions. The contribution of this area is generally minor, given the fact that the plant and roads, once built, will exist to help create product for many decades. In addition, such capital goods are commonly used for other products, as well. Therefore, normalized to the amount of product manufactured, GHG emissions from this stage of the life cycle are generally minor. However, in some cases, it may be significant, particularly in companies that must invest heavily in R&D (and R&D buildings) before the product is developed.

- **Development of raw materials.** While the company manufacturing the product generally assembles and sells the product, manufacturing depends on the gathering of the proper raw materials. Raw materials, such as metals and plastics for certain machinery or equipment, chemicals for other chemicals or pharmaceuticals, or food products to make other food products, are generally manufactured by other companies (or farmers) for which the company in question has a contract. GHG emissions from transportation of raw material to the manufacturing plant needs to be calculated, as well.

- **Manufacturing and production.** As discussed earlier in the baseline GHG emissions inventory, this is the combustion of fuel in boilers, the purchasing of electricity and steam, the emission of GHGs in the manufacturing process, and the use of mobile equipment directly to produce the product.

- **Transportation.** As discussed earlier, this is the transportation of product in trucks, barges, or airlines to warehouses and/or retail stores. Depending on the manufacturing plants and warehouse and retail locations, this could be significant source of GHG emissions.

- **Sales and Consumer End Use.** Once the product is transported, it stays in the retail store, potentially causing GHG emissions. A greater GHG emission potential is consumer end use. The product, most likely, will be used by some end consumer, potentially using electricity or causing a fuel to be combusted. Based on the nature of the product and its properties, more or less GHG may be emitted.

- **Waste Management and End of Life.** After the product is used, it must be disposed of. It may need to be transported, causing GHG emissions. If it is disposed in a landfill, it may result in CH_4 emissions, a potent GHG. On the other hand, the product may be recyclable. The act of recycling may cause GHG emissions, but in many cases, this is much lower than the GHGs emitted when manufacturing a new "replacement" product.

LIFE CYCLE ANALYSIS (LCA)

The aforementioned six categories represent the life cycle of a product. An LCA can be performed to assess the relative contribution of these different categories to total GHG emissions related to a product. The results can assist a company in comparing its product's GHG emissions to a competitor's products. In recent years, major retailers, such as Wal-Mart and Tesco, are requesting such LCA information for a growing number of products, so that consumers will eventually have appropriate information for comparative purposes. It is anticipated that in time many products will have "carbon labels" perhaps similar to current nutritional labels on food products. Also, information from an LCA can allow a company to prioritize what areas to focus its resources to reduce GHG emissions.

The only accepted international standard for performing an LCA was issued in 2006 by the International Standardization Organization (ISO), as "ISO 14044". It was reviewed and confirmed as still the standard for conducting an LCA in 2022. Therefore, besides following this procedure, the engineer performing an LCA must use common sense, gather complete, relevant and accurate data, and use a transparent, engineering approach to estimate GHG emissions from the life cycle stages. This involves gathering information from many other companies involved in the different stages of the product. Data gathering involves suppliers of the manufacturing processes, such as mining of metals, chemical reactions to form plastics, energy consumption to manufacture chemicals or food, etc. A thorough LCA would also involve data on transportation to get the raw materials to the company's manufacturing facilities.

One must start the LCA by determining a unit quantity, such as 1 MW electricity, a 2-liter bottle of a soft drink, a unit of "widgets", or 1 tonne of chemicals produced. Then one must determine the activities along the life cycle needed to make that unit quantity. Given these examples, and assuming we are discounting the building of the power or chemical plant, what are the raw materials necessary to create the 1 MW of electricity (fuel combusted), the soft drink (the plastic to make the bottle and the ingredients of the liquid), the "widget" (metals, plastics, etc.), or the 1 tonne of final chemical (raw materials that react or carry to form the chemical)? What actions are involved in their production and transportation (bringing the fuel out of the ground and refining it, transporting it to the power plant; and manufacturing the chemical and transporting it to the company's plant)? What are the GHG emissions from the production of that quantity of fuel to create 1 MW of electricity or 1 tonne of chemical?

Next is GHG emissions from the production of the product in question. The baseline GHG emissions inventory discussed earlier should help determine these emissions. It should be applied to the base case of the activities and GHG emissions involved in creating the 1 MW of electricity or 1 tonne of chemical. Annual GHG emissions for the plant from the baseline inventory can be divided by the number of MW of electricity or tonnes of chemical produced to generate the figure necessary from this part of the carbon footprint.

Next is GHG emissions from transportation of the product from the plant to a warehouse or user/customer. For electricity, it would not include traditional transportation by trucks or other mobile sources, but may include losses of SF_6 used in transformers. For chemicals, it would include all transportation from the company's manufacturing plants to the various warehouses and consumers or retailers.

The next area to evaluate is the end user, the consumer. Are there any GHG emissions related to the use of the product? For the chemical or product, it may be used in a process that involves fuel combustion or electricity usage for optimization. Is the chemical something whose use decreases fuel combustion or electricity usage, such as a boiler water softener or building insulation? These items need to be considered. Is the subject chemical used by the consumer in some capacity that will cause GHGs to be emitted?

The final area to evaluate is end of life, recycling, or waste management. For electricity, this is probably not an issue. For the chemical, the effort to transport the waste product to a landfill and its potential formation of methane (CH_4) needs to be considered. Any recycling that would reduce the quantity of chemical manufactured anew can be taken for "credit".

An LCA can produce GHG emission results of kg GHGs per unit product for each of the stages listed above. Results can indicate that one or two stages are the locations of most of a product's GHG emissions. For example, in a public presentation, a major manufacturer of kitchen appliances performed an LCA on its products, and determined that 95% of its GHG emissions came from one phase of the life cycle: consumer use. For example, the refrigerator that the company manufactures uses electricity in people's homes 24 hours per day for many years. This indirectly causes GHG emissions much greater than those from its manufacture, production of raw materials, transportation of appliances to the retail store, and transportation of broken down appliance to a landfill. This information allowed the company to focus their climate change program on making their refrigerators and other appliances more energy efficient in their consumers' homes.

One other example is a yogurt manufacturer who performed its own LCA, and determined that 70% of their GHG emissions came from one life cycle category: its raw materials; or more specifically, the methane coming from the dairy cows and the high energy usage of pasteurizing and treating milk before it leaves the dairy farm. Although transportation appears to be a significant category of GHG emissions (shipping of yogurt for hundreds of miles in refrigerated trucks which likely get poor gas mileage), this was determined to be much less than the raw materials, mainly because of methane's high

global warming potential. Given this information, the yogurt company decided to begin a purchasing program focused on minimizing GHG emissions from their suppliers (the dairy farms) by mandating certain cow breeding practices and energy conservation technologies as a pre-condition to buying their milk to make yogurt.

LCA is a useful tool to determine the GHG emissions from a product's entire life cycle. It can enable a comparison with GHG emissions from competing products (if the LCA is conducted by the same procedure). This is clearly what major retailers like Wal-Mart and Tesco hope to achieve for its customers. By preparing an LCA and performing the followup actions, these companies will likely be at an advantage over their competitors should LCA's become required for their products. As seen above, the LCA also provides information to allow the company to focus on procedures that would reduce the most GHGs in the fewest activities.

LCA may also be a useful tool in one other GHG context. An LCA may be used to study different fates of a product. If a precursor is removed from the preparation of a certain product and undergoes a different series of steps to form a different product, an LCA can compare the different GHG emission fates of the originating compound(s). The LCA can estimate GHG emissions from the production, transportation, use, and waste management to form and use the "traditional" product and from the production, transportation, use, and waste management to form and use the "alternative" product. If the alternative product results in lower GHG emissions, then this could be a major selling point for the alternative product or process.

GHG EMISSION REDUCTION OPPORTUNITIES

Once the baseline GHG emissions inventory, carbon footprint, or LCA is completed, the company should look for opportunities to cost-effectively reduce GHG emissions. As mentioned earlier, there are many convincing business and environmental reasons to do so. In many cases, there is a payback for the effort.

There are no end-of-pipe air pollution control pieces of equipment to control most GHG emissions. One exception is a flare to convert methane in an exhaust (often collected from landfills) to CO_2, a much less potent GHG. The most effective way to reduce GHG emissions is to reduce energy usage, fuel combustion and/or electricity usage.

GHG emission reductions, therefore, begin with an energy assessment or energy audit. A thorough, professional energy audit has shown reduction opportunities of as much as 30 to 50%. The effort should not merely be "counting light bulbs", but a systematic review of energy usage and losses.

Energy assessments or audits are a whole different field of study, but such work generally involves the evaluation of the processes where the facility spends the most money on energy use. The audit focuses on those processes to determine areas of reduction. A number of potential opportunities are identified, ranging from "low hanging fruit",

relatively inexpensive but effective opportunities, to less cost-effective opportunities. Because of the high cost of energy these days virtually any energy reduction idea will pay for itself in time. The questions are what is the payback time and the degree of time to realize the reduction in GHG emissions. An energy audit or evaluation reducing energy usage also positions the company in a more secure, less risky position in terms of future energy supplies and availability.

There are two main areas to reduce energy usage at a facility: 1) heating, ventilation & air conditioning (HVAC) and 2) lighting. Physically upgrading or changing maintenance procedures for boilers, chillers, and air conditioning systems may be expensive, but can result in significant long-term reductions in energy use and GHG emissions. As mentioned earlier, as a result of your baseline GHG emissions inventory, you may be able to select target facilities and operations with high normalized GHG emissions whose HVAC systems should be subject to review and potential overhaul to save energy and reduce GHG emissions.

Lighting is another large electricity user. As has been highly publicized, replacing incandescent bulbs or fluorescent tubes with LED lighting can reduce electricity consumption by over 50%. With the price of LED lighting going down and the cost of electricity rising globally, replacement of all incandescent and fluorescent lighting is an obvious first step. However, there is more that can be done besides simple bulb replacement. A lighting audit can be performed to determine whether your facilities are effectively using the light fixtures that you have, in terms of shining the appropriate number of lumens where necessary. Such audits may demonstrate that your facilities use too many fixtures shining too many lumens on areas where so much light is not necessary. For example, less light can be shone on areas that are not occupied. Lighting controls that can, for example, turn off or to dim lights in areas not in use during a given timeframe can result in significant electricity savings and GHG emission reductions while even improving the necessary lighting in your offices, retail areas, work shops, and other critical facilities.

One other avenue of GHG emission reduction is through “Green Building”. The U.S. Green Building Council (USGBC) has developed a complex series of standards called “Leadership in Energy & Environmental Design” (LEED). Being LEED certified allows an existing or new or renovated building to be indisputably designated as “green”. This involves not only minimum energy efficiency standards, but rewards for going beyond the minimum standards. All of this results in minimizing GHG emissions. In addition, the LEED program also involves waste minimization, recycling, water conservation, and other high performance practices, which may also reduce GHG emissions, when the life cycle of the building is taken into consideration. Buildings may be designated as LEED-Certified, LEED-Silver, LEED-Gold, or LEED-Platinum. There are separate LEED standards for existing buildings, new construction, and a growing number of other categories. While LEED certification is not required for a GHG program, it is another recognized, well-respected label for facilities to show the public and shareholders that your company is committed to good social practices. A “gap analysis” can be performed

to determine how many LEED points an existing facility has and what cost effective steps can be done to meet or raise its LEED status.

ESTABLISHING GHG EMISSION REDUCTION GOALS

A company can now use the quantified and wide range of GHG emission reduction opportunities and select those that make the most sense. These cumulative reductions can be used as a basis to determine a GHG emission reduction goal relative to the baseline. Most companies select a GHG emission reduction goal as a percent decrease from the baseline. Since there are no regulations mandating reductions, the company can choose the percentage reduction and time schedule it feels most comfortable with. This can be based on the number and timing of energy-saving projects selected and their potential in reducing GHG emissions.

It is critical to keep in mind that such a corporate percent GHG emission reduction goal should not be based only on these projects. Sometimes reductions estimated "on paper" are not achieved to that extent in the plant. Also, even if a company is successful in reducing GHG emissions through these projects, GHG emissions may be increasing in other areas, possibly because of business or other growth and changes. Therefore, one must perform a careful overall business and engineering analysis before selecting a company-wide GHG emission reduction goal that is reachable for your climate change program.

In determining a GHG emission reduction goal, it is also important to note that reductions do not need to come only from operations that the company controls. The company can take credit for GHG emission reductions from outside its operations. Such reductions are called "offsets". Given the understanding that a tonne of GHG emission reductions achieved anywhere in the world is equivalent, a company does not need to restrict its GHG emission reduction efforts to only their facilities or the processes they control. It may be more cost effective to implement or sponsor such emission reductions outside of its operations.

In evaluating offsets, companies can begin by examining their product life cycle (LCA, as discussed earlier) and develop projects to reduce GHG emission reductions related to their product but incorporated by others in the life cycle (such as, the yogurt manufacturer mentioned earlier). Besides the fact that a different company would be responsible for implementing the project, the company can reap the social benefit of reducing GHG emissions and put its product in a more competitive position for selling it to the public. Although the company did not achieve the reductions, it can better associate the reductions with their products and company name. Ultimately, this can have a positive impact on potential retailers and customers and their opinion regarding the company's products.

Companies can also "offset" their emissions by finding opportunities completely outside their product "footprint" by contributing to GHG emission reduction efforts anywhere in

the world. Companies can verify such a permanent GHG emission reduction could receive sellable credits. The European Union market has a healthy trade exchange. For example, an early approved CDM project ever was a German energy firm which invested in and built a hydroelectric plant in an underdeveloped portion of Guatemala. It brought power for the first time to a region of the country without causing long-term emissions of GHGs. The firm received CERs equivalent to GHG emissions that would have been had it been a typical fossil fuel powered plant.

In the U.S., the CDM program is not applicable. However there is an unregulated voluntary market of emission or "carbon" offsets. A company can invest in an energy reduction project and receive credits (if negotiated with the recipient entity) that can offset current GHG emissions. There are for-profit and NGO firms that have invested in and obtained credits ("carbon offsets") for successful GHG emission reduction projects that may be purchased. In addition, there is a market for Renewable Energy Certificates (RECs) for facilities replacing electricity developed from fossil fuel origins with that developed from renewable sources (solar, wind, geothermal, etc.). There is also a market for Energy Efficiency Certificates (EECs) for companies which have achieved an increase in efficiency, defined as producing the same amount of product using less electricity or fuel. It is very important to note that the market for carbon offsets, RECs, and EECs is unregulated by the government. Therefore, it is incumbent on the buyer to thoroughly research the origin of the credits or certificates it is purchasing to ensure that they are valid, based on actual, verified GHG emission reductions or renewable energy use that meet proper standards, and is not subject to "double counting" (the same reductions being sold multiple times).

However, it should be noted that in the voluntary U.S. market, it may be more cost effective to procure offsets rather than spend large capital up front for in-house GHG emission reductions which may result in a smaller reduction than anticipated. In other words, proper offsets may be less risky and costly than certain in-house GHG emission reduction projects.

The company must invest effort to ensure that energy efficiency and GHG emission reduction projects are implemented properly and monitor that the emission reductions were achieved and will remain long-term. Remember, for most programs to be allowed to count as a successful GHG emission reduction, the reduction must be real, permanent, and transparent. Verification by a third party is encouraged. Also, the company must expend effort to research the availability of offsets from the market or by investing in certain projects. The company must have a full understanding of the validity of the project and its offsets and ensure that its image does not negatively impact the company's.

In summary, a company must use its engineering and business resources to determine a GHG emission reduction goal. It needs to fully understand the nature of its baseline emissions inventory and related carbon footprint. After an energy audit or assessment identifies which projects represent good opportunities to reduce energy usage and GHG emissions ("low hanging fruit" or similar) and assessing the U.S. voluntary carbon

market, the company can now use engineering and business principles to set a reasonable, achievable GHG emission reduction goal, that may well be a combination of successfully implementing in-house energy reduction projects, management of other carbon sources, and helping to implement GHG emission reduction projects within the "footprint" of the company's products and even completely outside company operations.

REPORTING SUCCESS

After the baseline GHG emissions inventory is complete, the emission reduction strategies are developed, implemented, and taken through to permanently reduce GHG emissions, the company can now report successful GHG emission reductions. Proper reporting and documenting of your GHG emissions is important for several reasons. It is critical to record your exact methodology so that it remains consistent from year to year. With turnover in staff, consistency over time is a challenge. A robust report is critical.

Although not discussed earlier, there will likely be early action rewards in a future U.S. federal GHG rule and in the replacement global protocol for Kyoto beginning in 2013. Proper transparent documentation of your GHG emission reductions is critical to ensure that your company will get the maximum future credit for its current actions which will lessen your future regulatory obligations under these rules.

Reporting may be performed in two ways. In each case, it is critical that your efforts be transparent for authorities to review your actions for potential regulatory or financial credit and also because of future staff turnover; new personnel should be able to follow the same methods as previous. One can prepare a traditional "text" report, providing detailed background about climate change, discussing the methodologies, and showing raw and calculated data in an appendix. An alternative is an Inventory Management Plan (IMP), an abbreviated format with methodologies spelled out, usually in bulleted form. Some find this format more useful in keeping the methodology consistent and in knowing when the official methodology has changed. In either case, a major goal for either report is to keep the exact methodologies for performing annual GHG emission inventories transparent and consistent with accepted global standards.

Of course, when your company has achieved a successful reduction in GHG emissions, the Communications Group should publicize it internally and externally through publications, such as internal newsletters, your website, and external registries. Several registries exist in the U.S., such as The Climate Registry and the USEPA's Climate Leaders Program. This tells the public that the GHG emission reduction goals have been met. The Climate Registry requires third party verification.

In a world that is beginning to question claims of GHG emission reduction goals and successes, it is advisable that any GHG baseline inventory and emission reductions be certified by an experienced, reliable, and independent third party. It is likely that early action rewards will require third party verification.

As discussed earlier, GHG emission reductions may be reported in tonnes per year reduced or percentage reduced. But emission reduction data can also be reported on a normalized basis to a critical production metric, such as reduced GHG emissions per "widget", per gallon of oil produced, per square foot of office space, etc. This allows a more meaningful comparison of emissions between companies in your industry and between internal facilities and operations as climate change is a living program.

Finally, once GHG emission reductions have been achieved and certified, the company can look into the possibility of being issued carbon credits by an organization which may turn around and sell to buyers. The market for such carbon credits in the U.S. is growing lately, as more companies and events wish to be called "carbon neutral". For example, the last Super Bowl was carbon neutral, all because the National Football League purchased sufficient credits for reductions elsewhere to offset the electricity usage and fuel combustion related to the event. Several organizations will either issue carbon credits or pre-fund some of your GHG emission reduction projects in return for the rights to all ensuing carbon credits.