Paper 343-2009

Carbon Footprint Modeling with SAS® for Sustainability Management: Beyond Calculation

Keith Renison, SAS Institute Inc., Cary, NC

ABSTRACT

In the 2008 McKinsey Quarterly article "Business Strategies for Climate Change," the authors explain that "The winners will be companies that reposition themselves to seize the opportunities of a low-carbon future." This statement has been echoed by analysts, academics, and CEOs alike. But how do you get there? Many organizations have endured the struggle of beginning to calculate and set reduction goals of their carbon footprint, only to find the traditional office tools fall short in providing tangible insight and transparency, not to mention the absence of quality data.

This paper will explain the differences between calculating and modeling emissions, the critical parallels between cost and greenhouse gas (GHG) accounting, collecting and managing data, and using activity-based modeling practices to gain invaluable insight from such efforts. Readers will be able to see how the technologies that are part of the SAS® for Sustainability Management solutions help enable these insights, and provide a way to manage and forecast consumption of economic and natural resources.

INTRODUCTION

I'll take for granted that all of us have been exposed to the now-fashionable term "carbon footprint." Regardless of the humans-are-the-cause-of-climate-change debate, the flurry of existing laws, imminent legislation, and popular discussion of greenhouse gas emissions indicates the carbon-conscious world is here to stay. Beyond the consumer marketing hype of online calculators and hybrid cars, lives the growing social and environmental responsibility placed on businesses of all sizes, across all industries, worldwide. Today, organizations have numerous reasons to measure and manage their atmospheric waste, not the least of which is to improve operational efficiency, reduce costs, and align external communication with stakeholder interests. The goal of this paper is to explore what happens when your organization chooses to develop competencies in managing carbon and finds that simply calculating and reporting a number for compliance is of limited value. Organizations must go beyond calculation into the world of activity modeling if real understanding, leadership, and goals are to be achieved. The rest of this paper will show how the combination of mature SAS technologies and innovative modeling techniques can be adapted to this contemporary business problem. We'll explore some of the parallels that make these technologies the right fit, and walk through some practical modeling practices that are being deployed at both SAS and our customers' sites.

LEARNING FROM THE PAST

Many years ago businesses were trying to manage their monetary resources, only to find that the true cost of their products, customers, or services was obscured by broad-based allocations. This was also compounded by the fact that traditional accounting methods didn't reveal the activities that were driving these expenses, specifically those activities the business could actually manage. Activity-based management was born. Early on however, spreadsheet-based applications designed to model these structures proved difficult to manage, lacked transparency, and were not robust enough to handle the complexities and scale that occurred in a real business. From that pain came the dawn of enterprise-class activity modeling tools such as SAS® Activity-Based Management.

The beginnings of this same evolution can now be seen in the carbon management space. Organizations have begun to calculate their carbon footprint by using spreadsheets or niche applications only to find that the number they get is spread across numerous spreadsheets, has little transparency into the calculations, and gives limited insight into how to manage it. Sure, it can suffice for compliance reporting, but the real competitive edge comes from fully understanding this number in the context of the organization's past as well as its future.

We've found that resources, whether economic or natural, have the same behavior when it comes to activity modeling. That is, the same archetype that is applied in activity-based management can be applied to money (traditional), water, energy, or in this case, emissions. Greenhouse gases (a by-product of a "natural" resource), are created directly or indirectly by the work activities of your organization. That work is performed because it is required in order to make the products and services that are delivered to your customers. People manage the work activities and make decisions about products and customers, not necessarily about the resource itself. As a simple example, to lower the energy use of a building, you must change the properties of the building itself, or manage what goes on inside that building. For this, you must be able to understand how these activities affect the use of the building, activities that most likely are not metered. Therefore, modeling, not calculating, becomes the new paradigm that reveals the insight necessary for decision making—something spreadsheets and similar tools have a difficult time doing. As Bras and Emblemsvåg (2001) describe in their book *Activity-Based Cost and Environmental Management*, "…from an ABC method's point of view, [other natural resources are] simply just another 'currency' and the principles remain unchanged." In the simplest terms, by replacing the "currency" of cost with other resources, we are able to gain the same insights about emissions, water, waste, or energy that have proven themselves invaluable to the cost-accounting world.

I hope you can see that just *calculating*, although a noble first step, will leave you in the same position financial accountants were years ago. To leap ahead and learn from the past, we must instead consider the application of *modeling* as a core practice behind any serious carbon management strategy.

MODELING FOR INSIGHT

Good modeling tools should be multidimensional. That's a fancy way of saying that your business has several aspects to it, some shared, some unique. For example, you might want to see different scopes of emission sources broken down by different geopolitical entities. You might also want to "slice" this view by organizational structures, asset types, the United Nations Framework Convention on Climate Change (UNFCCC) Annex designation, or simply over time. All these things describe different dimensions to your business. Some of these dimensions are spelled out in modeling protocols (such as the GHG Protocol, or the U.S. Environmental Protection Agency (EPA) Climate Leaders program), and some are required for management insight.

These dimensions should also be completely configured by the business and not require a programmer to rewrite the application when you need to make a fundamental change to the model. For example, a financial services organization is structured with different dimensions from say, a paper manufacturer. Likewise, businesses within the same corporate legal structure can be vastly different. Therefore, the business should be able to quickly make changes to the model regardless of these dynamics. Figure 1 displays a set of dimension hierarchies common to a carbon management model. There are two types of dimensions: dimensions that are structural, which are used to connect the flow of emissions from one place to the next; and descriptive dimensions, which are used to describe some aspect by which you will analyze. For example, most emissions are created by an asset, but that asset (if stationary) is located in a geographic region. Geography is a descriptive dimension, or in modeling nomenclature, an "attribute dimension."

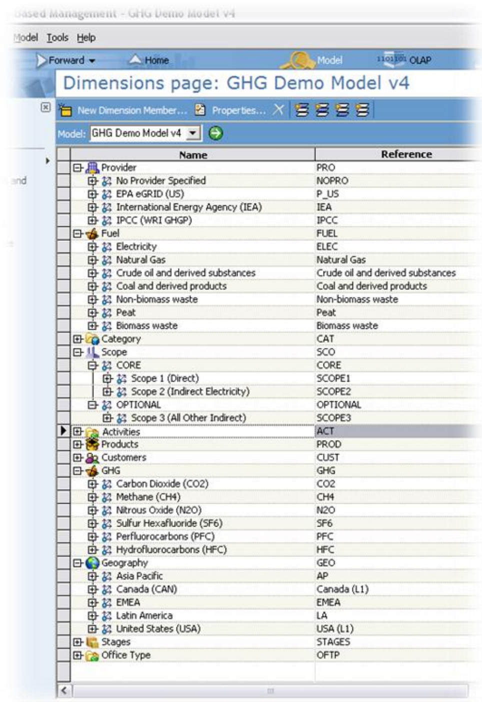

Figure 1: Commonly Used Dimensions

The following methods have been developed from our expertise in resource and activity modeling, real customer experiences, and in modeling our own business. That said, these tools are very flexible and many astute activity-based management modelers exist in the world today, so count on these methods and practices to evolve.

EXTERNAL UNITS

An external unit can be described as an entity that exists outside the business that is created when a demand is placed on it. The External Units module of SAS for Sustainability Management contains a catalog of rates of emission sources provided by third-parties. For example, the U.S. EPA breaks the United States into energy grid sub-regions, providing emissions factors (unit rates) for three of the six standard greenhouse gases recognized by the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs). The rates shown in Figure 2 are for electricity. However, there are many other fuels and emission sources required by most accounting standards that involve the other gases. These gases are modeled independently here because each one carries a different rate and different atmospheric warming potential. Therefore, for this module, we have chosen to model three dimensions: *Provider* (the entity that provides the rate); *Fuel* (the type of fuel or emission source); and *GHG* (greenhouse gas).

The intersection of these three dimensions is represented by an account, and arranged in a hierarchy. An account contains all the information for that intersection, such as the unit rate, unit of measure, driver, attribute dimensions, and so on. So in this example, we have an account that carries the raw rate for each greenhouse gas in terms of pounds emitted per megawatt hour of electricity consumed for the energy grid that serves the U.S. states of Virginia and North Carolina. Notice that the rates provided by the EPA are in terms of pounds per megawatt hour, whereas the International Energy Agency uses grams per kilowatt hour. (See the IEA rate for Australia as an example.) The unit of measure provided by the third-party source should be retained in the model for transparency. These rates are later normalized to the carbon dioxide equivalent (CO_2e) and converted to a common "currency," which in our case is in terms of metric tons (*t*) of CO_2e. This will enable us to account for emissions in terms of total warming potential, total greenhouse gas volume, or both.

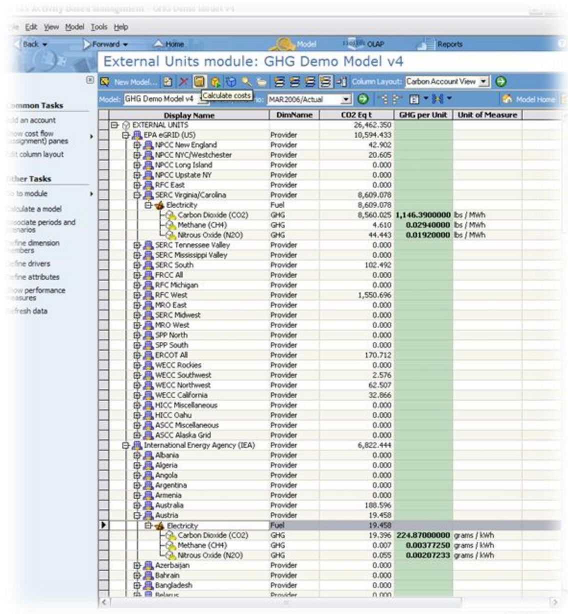

Figure 2: External Units

RESOURCES

The Resource module contains all the resources we use, directly, indirectly, natural, or economic. That is, it contains all the same goodies we see in the External Unit module, minus the greenhouse gas detail. This is because these accounts represent the bridge between the third-party rates and the way in which they are metered. The Resource module contains "roll-up" of emissions to a common denominator—CO_2 equivalents—that are consumed by physical activity or assets (meters attached to a building). For example, we don't receive a bill for how many units of a particular greenhouse gas are released when we run our data center. Instead, we get a bill for the consumption of the fuel in terms of kilowatt hours of electricity. So it doesn't make sense to pull directly from the low-level GHG account. Instead, we "assign" the gases to a roll-up account in the Resource module by using a variable driver quantity of one. This effectively assigns one external unit (at the rate specified) for every consumption unit of the resource (electricity). We also use a weighting factor to hold what is called the "greenhouse gas warming potential." Warming potential refers to how many times greater than straight CO_2 the gas is at trapping heat in the atmosphere. CO_2 represents the vast majority of the warming gases by sheer volume. However, all these other gases are much better at trapping heat. Therefore, this first assignment step uses a driver variable weight (a multiplier) value equal to the warming potential. This effectively multiplies the unit rate by the warming potential for each unit of consumption. Figure 3 shows one such assignment.

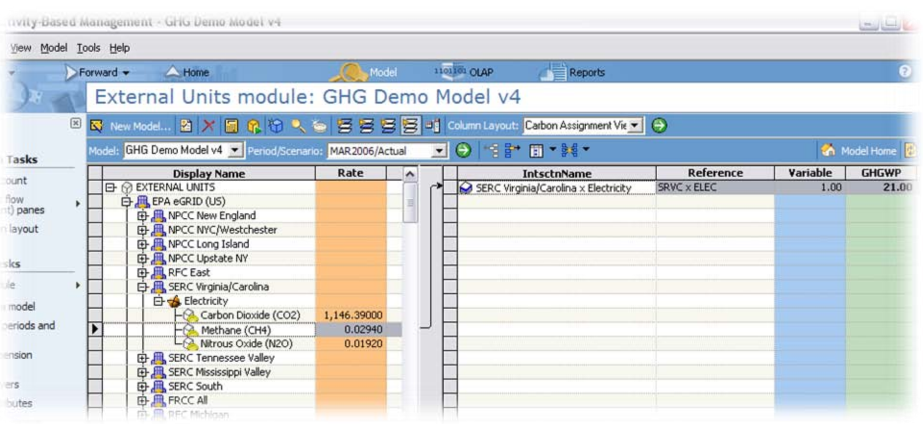

Figure 3: External Unit Assignment

External units and resources are fueled by third-party sources. Many of these structures can be pre-populated, re-used, and shared across organizations, expediting the model-building and maintenance process.

ACTIVITIES

Now that we have a catalog of fuels and emission sources to pull from, the fun begins. The Activity module is used to collect the structures and work activities that consume resources, or in this case, generate a by-product from said consumption (external units). In most cases this starts with physical assets and other items that are required for compliance reporting. For example, an electricity meter attached to the outside of a building is doing something—measuring other work that's going on inside. We therefore create an activity account for the meter where we will assign the proper emission source account, and enter the amount of work it is doing. This "amount of work" is essentially the total energy use from your bill for a given period of time. This is entered into the model as a Fixed Quantity (kilowatt hours). This is because the metered volume tells you exactly how much you used in total, and our intention is to get the emissions "pulled" through the assignment (the link between accounts), and pooled into the account. In all likelihood, your organization will have multiple meters that pull from the same source rate provider. In our example model, you can see that there are indeed 13 meters across 11 buildings that are "pulling" from the Virginia-North Carolina grid (Figure 4).

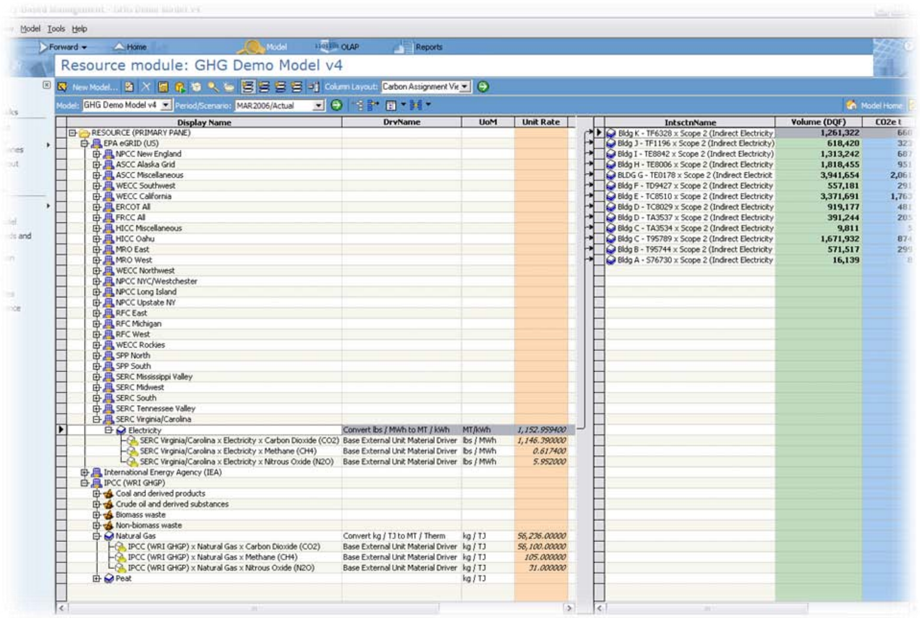

Figure 4: Asset Consumption

It is more common than not for the unit by which you are billed to be different from the unit provided. Additionally, the amount of GHG specified by the external unit will likely be in a different unit of measure from your base "currency." In the example, the EPA provides the rate of GHG in terms of pounds of GHG per megawatt hour. However, we are billed in kilowatt hours, and our common base "currency" is metric tons (tonnes, or abbreviated as *t*). In order to keep all the calculations within the model, we must use a calculated driver for the assignment with the following formula:

(DriverQuantityFixed / 1000) / 2204.6226218

This formula converts the driver quantity entered (kWh) to megawatts by dividing it by 1000, and then divides it again by the number of pounds in a metric ton. Through its relationship with the resource account (and upstream link to the emission rate accounts), the product of this driver formula is used to pull one increment of GHG (the unit placed on the external unit account), multiplied by the weighting factor (warming potential, the result of which is a pre-calculated CO_2e [1152.9542] value rolled up to the fuel level). This effectively drives the actual amount of CO_2e to the meter. In the example, the calculation for "Building K" looks like this:

$$(1{,}261{,}322\ kWh\ \div 1000) \div 2204.6226218 \times 1152.9594 = 660t\ CO_2$$

We can create an unlimited number of driver formulas that can be reused across accounts, models, and even different companies. This flexibility makes it possible to model even the most complex relationships, while enabling full transparency of how the numbers were created. Because driver formulas are user-defined, everything from heat content to weight and mass conversions is at your disposal.

Typically this first stage of emissions that are associated with assets represents your Scope 1 and 2 emissions. That is, those direct and indirect emissions commonly required for compliance reporting. This is often where most carbon calculators stop. This is because they tend to be purely focused on the calculation of emissions for compliance, not on resources in general, and not as a means to explore drivers that go beyond physical measurement and into the world of management. Many businesses also have environmental exposure that is outside their compliance requirements. Using these same methods, we can extend the model to other Scope 3 emissions that are important to the business, such as auto rental, commercial air travel, third-party product transportation and logistics, employee commute, and so on.

Let's now borrow practices proven in activity-based cost accounting, and identify ways by which you will use emission information to make decisions. In this, we can further distribute emissions based on the business use of the emissions pools that are sitting in the asset accounts. This should spark a number of questions, such as what drives your emissions? Is it the different types of square footage in your facilities? Data centers? How is it measured? Should the reduction of emissions be the burden of the business units that consume energy or IT resources? What work is done inside the building that is responsible for spinning the meter on the outside of the building, or for burning that fuel in the corporate jet or fleet vehicle? These are the questions that should be asked when creating the design for your model.

In exploring the Activity module (Figure 5), we can see the flow of emissions from assets to a given department, and then further allocated to the different activities of that department. Notice these assignments are based on a variety of drivers, such as square footage and airline miles flown. Here, any number of possibilities can be modeled depending on practical needs. The point is to model to the level of detail that is required for management decisions, and use the most practical drivers that represent actual work (and encourage certain performance), balanced with the level of effort to collect the information. If department managers need to understand their relative ability to have influence over their pieces of the overall organization's carbon reduction goals, then a perfectly exact number isn't necessary. Instead they need to see their proportion to their peers, and how what they do affects the overall footprint. They must also have full transparency and buy-in into what methods were used in creating that number if it's to be trusted, and subsequently managed.

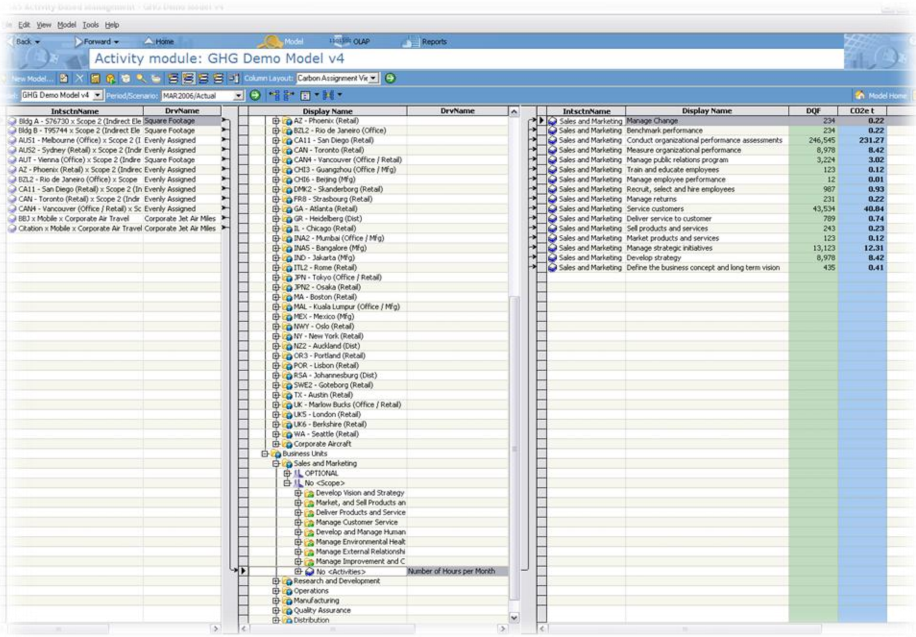

Figure 5: Full Emission Activity Flow

PRODUCTS AND SERVICES

The last step in the modeling process is to push emissions into the products and services you deliver (Figure 6). Because we now know the relative contribution of emissions to different types of work (fully burdened emissions associated with manufacturing products, or supporting customers), we can use different drivers to allocate resources that best make sense. These are typically production volumes, number of invoice processes, number of customer complaints, and so on. Again, the trick here is to use the most reasonable driver and volume that best represent the demand relationship. From the Activity module on, we can follow the same principles in activity-based costing. As mentioned earlier, using the tool's ability to model parallel scenarios, we can model cost, carbon, energy, or practically any resource in parallel, using many of the same drivers**,** just different resources. This reduces the amount of work necessary to eventually extend your model across other resource types. All we're really doing is switching out the first module, the type of resource being consumed, and using the same allocation practices.

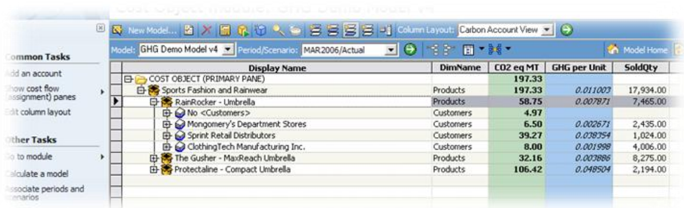

Figure 6: Products and Customers

DATA INTEGRATION AND AUTOMATION

One of the most difficult challenges with carbon modeling is the availability of trustworthy source data. Most organizations are in the early stages of carbon management, which often makes the existence of data illusive, disparate, or requiring manual data entry. These issues are significant, but not insurmountable. In fact, I believe the electronic collection of source data will be commonplace sooner rather than later, and already organizations have shown their ability to overcome this. For this reason, it is important to consider a solution that also has the capability to tap into a vast array of data sources (not just import spreadsheets), as well as bridge the gap with manual survey or data entry. This critical future requirement is why the renowned and scalable data integration capabilities of SAS are inherent to the solution. Though we could talk for hours about the data integration prowess of SAS, it is important to note that all model data, including structures and periodic information, can either be manually entered, surveyed, or built and maintained entirely by import.

ANALYSIS AND FORECASTING

A carbon management model wouldn't be complete without the ability to analyze, forecast, and communicate the results. As mentioned earlier, a good model should be multidimensional. Because we're using multidimensional modeling techniques, we can "slice" the information based on any of the dimensions we used in the model. The following figures show a number of common ways to view the information.

Figure 7 shows the ability to explore the "contributions" of emissions across all model dimensions. Beginning with a specific starting dimension, we can drill "back" through the assignment structure, selecting any dimension, at any level. Here we can see the composition of emissions across a given Geography (to a City level), into buildings, then even back into the type of greenhouse gas. The right-click context menu displays all the drill-through options. This view is particularly good at answering a variety of exploratory questions, and can facilitate discussions with executive information consumers who might be familiar with the topic in general, but unclear on the composition of emissions and hotspots within the organization.

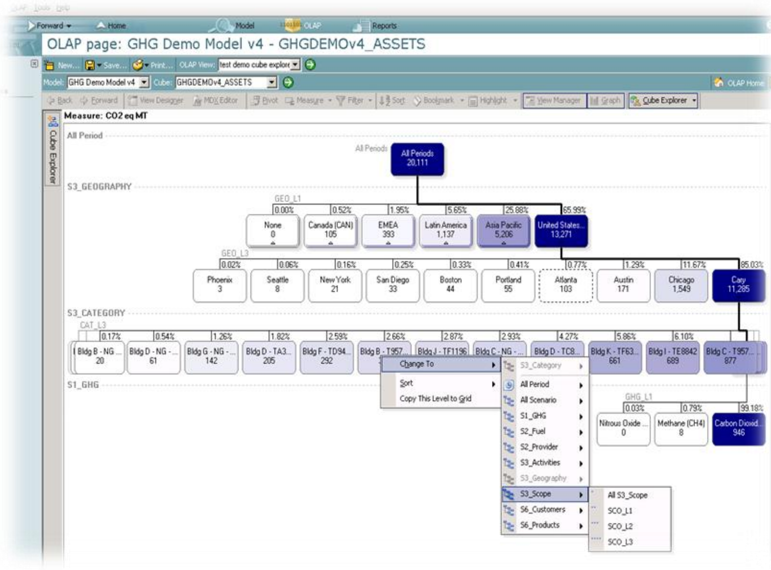

Figure 7: Cube Explorer View

With robust software, there are countless ways to display the model results, from line graphs to bar charts, to tables with exception highlighting (Figure 8). These views are built into the modeling tool, and are designed for the experienced modeler to validate results and develop insights. These insights become the basis for externally publishing the information to stakeholders. There are often a wide variety of stakeholders, from executive councils concerned with overall progress, to IT management staff concerned about energy consumption, to human resources specialists checking on the progress of commuter programs. Many of these stakeholders are not concerned with how the models are built, but instead with their specific performance. This makes the Web-based information delivery technologies included in SAS for Sustainability Management more appropriately suited for wide distribution and benchmarking of selective results.

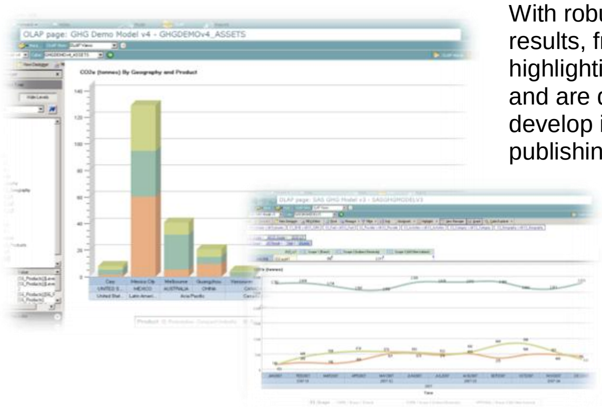

Figure 8: Integrated Analysis

It is also important to use the model results combined with the advanced forecasting ability of SAS to predict where emissions will be in the future. This includes the use of SAS® Forecast Server for comprehensive hierarchy-based forecasting (for example, to run multi-level forecasts for all assets aggregated across all geographies to help set company-wide reduction targets). Also available are custom "what-if" forecasting tools that enable you to make changes to "business as usual," to see how those changes might affect your emissions in the future (Figure 9). After all, most organizations that are becoming more carbon conscious are doing so because they have set some sort of reduction target. It makes sense then, for them to use appropriate tools to not only model the past, but to confidently make fair estimates of obtainable goals (rather than the traditional method of throwing darts).

CONCLUSION

I sincerely believe we are on the cusp of an important breakthrough in the application of technology to address sustainability management challenges. A resource is a resource, whether it is economic or natural. For greenhouse gas modeling, we can adapt methods, skills, and technologies that have already been proven successful in the field. The assets are consumed or produced by our work in very much the same ways, and for years we've worked to understand only the economic slice, leaving a massive amount of capability untouched. As Esty and Winston (2006) so aptly wrote, "In a marketplace where other points of competitive differentiation, such as capital or labor costs, are flattening, the environmental advantage looms larger as a decisive element of business strategy." By ignoring the impulse to simply calculate, and instead take advantage of an enterprise class business-modeling tool, your organization can move beyond compliance and provide insight to fuel a competitive advantage. If nothing else, let me leave you with one more piece of advice that will guarantee some economic and natural resource savings: please consider the environment before printing this paper.

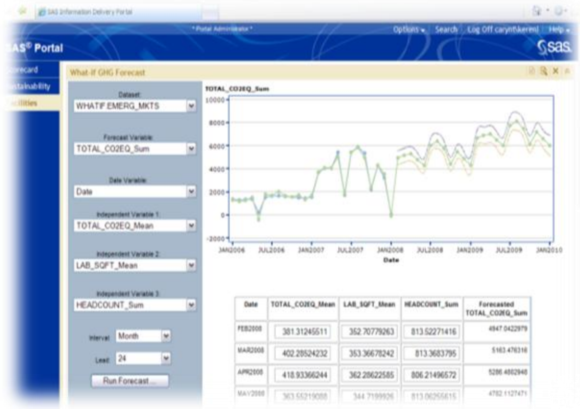

Figure 9: What-If Forecasting

REFERENCES

Bras, Bert, and Jan Emblemsvåg. 2001. *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance.* Norwell, MA: Kluwer Academic Publishers.

Enkvist, Per-Anders, T. Nauclér, and J. M. Oppenheim. 2008. "Business Strategies for Climate Change." *The McKinsey Quarterly.* Available at http://www.mckinseyquarterly.com/Business_strategies_for_climate_change_2125

Esty, Daniel C., and Andrew S. Winston. 2006. *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage.* New Haven and London: Yale University Press.

RECOMMENDED READING

To learn more about how SAS is addressing sustainability, download a copy of the SAS Corporate Social Responsibility Report at http://www.sas.com/corporate/corpgovernance/csr-report.pdf.

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author:

Keith Renison
SAS Institute Inc.
Work Phone: +1 (503) 292-3673
E-mail: Keith.Renison@sas.com