

**Greenhouse Gas Inventory Summary Report
February, 2010
Oak Ridge National Laboratory
Sustainable Campus Initiative**

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Greenhouse Gas Inventory Summary Report, December, 2009
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Oak Ridge National Laboratory, Sustainable Campus Initiative

I) BACKGROUND: Sustainable Campus Initiative

The Sustainable Campus Initiative is an Oak Ridge National Laboratory (ORNL) Lab-wide effort. Its goal is to integrate energy and resource efficiency, cutting-edge technologies, operational and business processes, and behavior to achieve sustainability at work, home, and in the community. To learn more about the ORNL Sustainable Campus Initiative a website has been developed to provide information and garner support for this important program. The site, located at <http://sustainability-ornl.org> is continuously modified to provide the most up-to-date information to team members, employees, families, other organizations, and the community at large.

A definition of sustainability: “The balance of efforts necessary to simultaneously maintain and nurture our environmental, economic, and social wellbeing for now and into the future.”

In creating a sustainable campus, ORNL will

- demonstrate excellence and innovation in on-campus practices,
- share science and technology expertise in such areas as buildings, vehicles, and environmental management with others, and
- share the practical lessons learned as we strive for sustainability

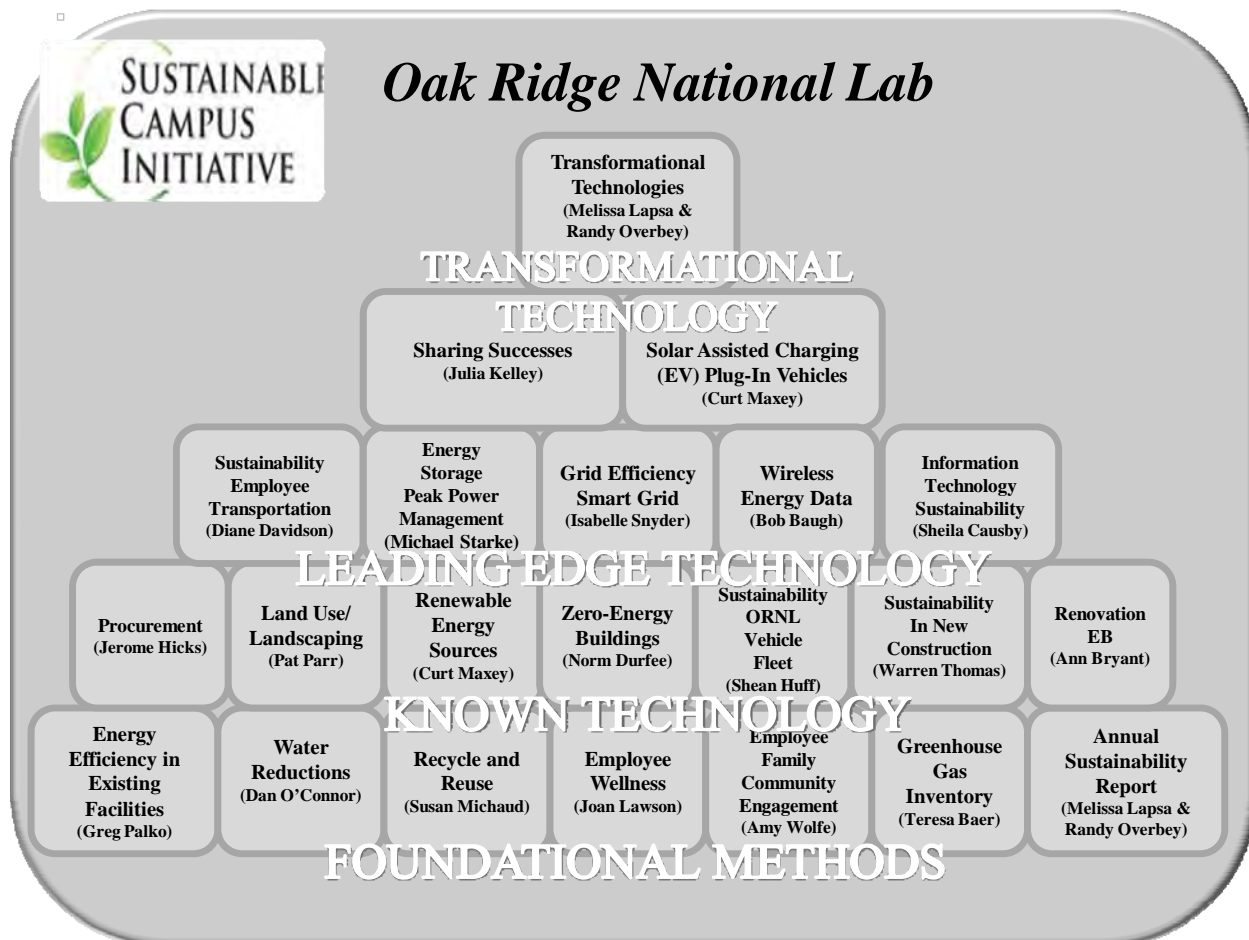
Thus, ORNL will be a sustainability leader - embracing sustainable practices and using its enormous expertise to benefit interested individuals, communities, commercial and industrial facilities, and the nation.

The Sustainable Campus Initiative in its current form was launched in 2008 as a ten year effort that has evolved over the past 18 months in response to a variety of dynamic inputs. The initiative currently consists of twenty-two (22) Roadmaps that describe specific steps/projects/programs that will help reach the Sustainable Campus goals. This report describes one of the foundational methods of the initiative, the Greenhouse Gas Inventory Roadmap.

II) BACKGROUND: Greenhouse Gas Inventory Roadmap

The Greenhouse Gas Inventory Roadmap is owned by Teresa Baer of the *Energy & Transportation Science Division; Energy & Engineering Sciences Directorate*. Major input and support to the roadmap was provided by a variety of ORNL staff and consultants as noted in each section. Guidance was provided by Melissa Lapsa, ORNL and Randy Overbey, E&S Consulting; reporting support and inventory calculation support was provided by Seaira Stephenson, XCEL Engineering. Greenhouse Gas Protocol guidance and reporting and calculation tools were provided by the World Resource Institute. Note: see section III (page 4 of this report) for more information about the World Resource Institute and other key definitions.

The Greenhouse Gas Inventory Roadmap is included in the Foundational Methods Tier of the Sustainable Campus Initiative to demonstrate the belief that managing greenhouse gas emissions is one of the basic principles for reaching a sustainable future. Understanding the measurement and management of greenhouse gas emissions and the effect these gases have on the environment is key to understanding how energy management is directly related to a sustainable future.



III) Fundamental Definitions of the ORNL Greenhouse Gas Inventory Roadmap:

Greenhouse Gas Inventory: The ORNL inventory is a measure of the amount of Greenhouse Gas emissions released into the atmosphere by direct and indirect activities, expressed in units of metric tons of carbon dioxide equivalencies (CO₂e).

Greenhouse Gases (GHGs): The six major gases that contribute to climate change as listed in the Kyoto GHG Protocol (The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), aimed at combating global warming. The UNFCCC is an international environmental treaty with the goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The Protocol was initially in 1997 in Kyoto, Japan. As of 2009, 187 governments had signed and ratified the protocol. The 6 Kyoto gases are:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Hydrofluorocarbons (HFC)
- Perfluorocarbons (PFC)
- Sulphur hexafluoride (SF₆)

World Resource Institute (WRI): A U.S. based, non-governmental and non-profit organization supporting research, education, training, and policy initiatives for environmental stewardship and sustainable practices. WRI is a major international center for policy research and analysis that address global resource and environmental issues.

Greenhouse Gas Protocol Initiative: A global-warming impact collaboration convened by WRI in 1998 to design, develop, and promote the use of standardized accounting and reporting principals in the estimating of GHG emissions and the calculations of greenhouse gas scopes and inventories. www.ghgprotocol.org

Global Warming Potential: A factor describing the radiative forcing impact (degree of impact to the atmosphere) of one unit of a given GHG relative to the basic unit of CO₂.

IV) **ORNL Greenhouse Gas Inventory Roadmap Process Overview:** "First to measure, then to manage, then reduce." *This report, issued in February 2010, primarily reports on the measurement techniques used to calculate the GHG emissions baseline. Detailed GHG management and emissions reduction plans will be covered in future studies and reports, currently under development.*

The process seeks to establish a baseline emissions inventory for FY2008 that is unbiased, justifiable, and transparent. Early in the process a decision was made to use the calculation tools and standardized accounting and reporting principals developed by WRI GHG Protocol, specifically the Public Sector Standard (PSS). The PSS is the third GHG standard published by the WRI and is

designed to be used by governments and other public institutions as they seek to build an effective strategy to measure, manage, and reduce GHG emissions. It should be noted that the WRI GHG Protocol, PSS, has been adopted as the primary standard used by the Department of Energy (DOE) in developing responses to the newly issued EO 13514. Though the EO was released after the ORNL Greenhouse Gas Inventory for 2008 was first produced, the adoption of the same tool by DOE in response to the new executive order validates the decision to use this standard.

Executive Order (EO) 13514 dated October 5, 2009. “Federal Leadership in Environmental, Energy, and Economic Performance” commits that the Federal Government will provide leadership in environmental stewardship practices. EO 13514 sets sustainability goals for Federal agencies and focuses on making improvements in their environmental, energy and economic performance. For the first time, all federal agencies are required to address GHG and Carbon emissions. All major agencies must set a 2020 greenhouse gas emissions reduction target. On January 31, 2010 overall Federal Agency goals were set at 28% with the Department of Energy target set at 25%.

In addition to the specific targets set for greenhouse gas emissions, Executive Order 13514 also directs federal agencies to increase energy efficiency; reduce fleet petroleum consumption; conserve water; reduce waste; support sustainable communities; and leverage Federal purchasing power to promote environmentally-responsible products and technologies.

V) Greenhouse Gas Inventory Roadmap Details: GHG Emissions Calculations and Steps in Measurements and GHG Inventory Calculations

1. Develop an Inventory Management Plan (IMP)
2. Set Organizational Controls and Operational Boundaries
3. Decide which Scopes to include in the IMP
4. Gather Data for Emission Sources in each Scope
5. Decide which Calculations Tools to employ for emission sources in each Scope
6. Calculate Greenhouse Gas Inventory Expressed in CO₂e
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Step 1: Develop an Inventory Management Plan

The Inventory Management Plan (IMP) is an internal process to assure the completion of a high quality inventory. This IMP Checklist is designed with internal considerations and assumptions in mind, not strictly as a reporting requirement to EPA, DOE HQ, or any reporting or regulatory agency. The IMP checklist outlines what components are included in the ORNL IMP and documents the assumptions made for each inventory/project element.

The IMP is a guiding document that provides a checklist to assure that each element in the project is accounted for properly. It allows us to document activity data and the owner of each activity data set. It allows us to capture inputs, reference documents and other information such as presentations and websites used by the team to complete the roadmap. The first table in the IMP defines our project, the protocol used to manage the project, and the GHGs to be measured: the following is a screenshot from the ORNL IMP for GHGs.

IMP Component			
Partner Information			
1.	Company Name	UT-Battelle LLC, ORNL	DOE Prime Contractor, Oak Ridge National Laboratory
2.	Corporate Address	1 Bethel Valley Road, P.O. Box 2008, Oak Ridge Tennessee	
3.	Project Manager and Contact Information	Teresa Baer, Project Manager baerts@ornl.gov , 865-241-8167	Greenhouse gas inventory Roadmap Owner, ORNL Sustainable Campus Initiative
4.	GHG Protocol Used for IMP	The Public Sector Standard, GHG Accounting and Reporting Protocol. Also known as the GHG Protocol Public Sector Standard (PSS) a joint WRI/LMI protocol http://www.ghgprotocol.org/	A stand-alone WRI document that modifies the Corporate Standard to provide guidance for public agency activity http://www.ghgprotocol.org/psp
4.a	Greenhouse Gases Measured	For the purposes of the WRI PSP standard, GHGs are the six gases listed in the Kyoto Protocol: The ORNL GHG Calculation will include all GHGs when reliable data and calculations are obtainable. In many cases CO ₂ , data is considered the most easily measurable, justifiable, and defensible. However all emissions sources for the six GHGs will be evaluated when possible.	CO₂ – Carbon Dioxide, A colorless, odorless, incombustible gas, CO ₂ , formed during respiration, combustion, and organic decomposition and used in food refrigeration, carbonated beverages, inert atmospheres, fire extinguishers, and aerosols. Also called <i>carbonic acid gas</i> . CH₄ – Methane, An odorless, colorless, flammable gas, CH ₄ , the major constituent of natural gas, that is used as a fuel and is an important source of hydrogen and a wide variety of organic compounds. N₂O – Nitrous Oxide, A colorless, sweet-tasting gas, N ₂ O, used as a mild anesthetic in dentistry and surgery HFCs - hydrofluorocarbons A substance emitted as a by-product of industrial manufacturing . A compound which contain carbon, fluorine, and hydrogen PFCs – perfluorocarbon , A compound consisting of carbon and fluorine. A compound in which all the hydrogen atoms of a hydrocarbon are replaced with fluorine atoms. SF₆ - sulfur hexafluoride, A colorless gas soluble in alcohol and ether, slightly soluble in water; used as a dielectric in electronics.

Step 2: Set Organizational Controls and Operational Boundaries

UT-Battelle/ORNL is a Government-owned/contractor-operated institution; owned by the U.S. Department of Energy, but operated in whole or part by the prime contractor. The organizational approach is based on financial control. The activities controlled by ORNL budgets include Research & Development, Facilities & Operations (F&O) and other activities that are dedicated to ORNL functions. Organizational and financial controls extend to facilities, employees and direct

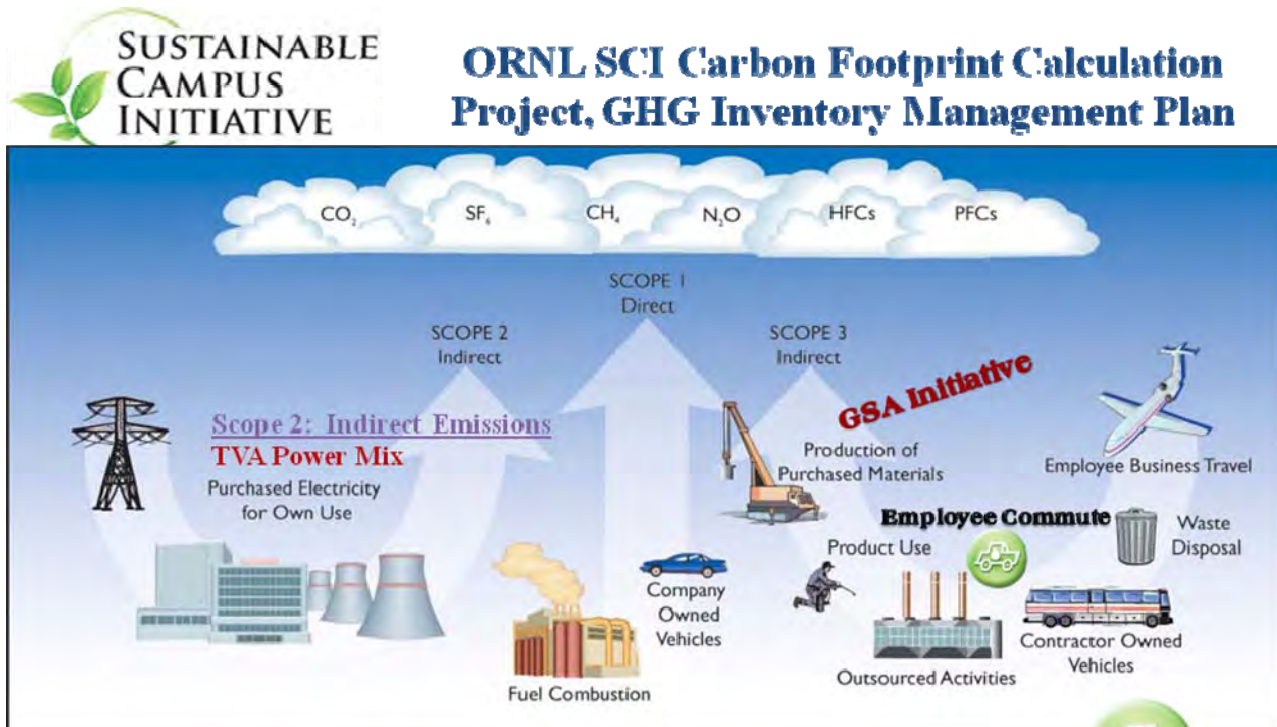
subcontractors. Control does not extend into other operations conducted on ORNL property that is contracted through other DOE Prime Contractors such as Wackenhut Security.

Geographic Boundaries were determined by the Oak Ridge Reservation Planning: Integrating Multiple Land Use Needs (May 2008). Of the 33,699 Acres in the Oak Reservation, approximately 2,900 are in the ORNL Operational Boundary. Energy usages for all facilities within these boundaries that are operated by ORNL, including utility operations, are included in our calculation. Facilities that are leased by other organizations such as CROET are not included in the Greenhouse gas inventory if the utilities are segregated and paid by another organization.

Facilities are accounted for as an aggregate total with square footage calculations and utility data as documented by F&O per DOE guidelines. For the Greenhouse Gas Inventory Roadmap we used the aggregate data as reported by F&O in the DOE EMS4 data base which collects data for fuel cost & usage, and utility cost and usage. *Note: For the purposes of reporting the Greenhouse Gas Inventory, data by individual building are not necessary, however, such data might be helpful when developing emission management and reduction plans.*

Step 3: Decide which Scopes to include in the IMP

This graphic represents the public sector activities that might be included within the Scope of the IMP. Activities are broken into three Scopes to represent the amount of influence an entity can expect to have on the type emissions and the amount of carbons released into the atmosphere.



- Scope 1. Direct Emissions**
- Natural Gas Usage
 - Fleet Vehicles
 - Generators, Stacks, Hoods

- Scope 3. Indirect Emissions**
- Employee, Contractor, Visitor Commute
 - Employee Business Travel
 - Waste Disposition



Scope 1 includes emissions from activities owned or controlled by ORNL and produced onsite.

- Direct Energy usage such as natural gas and fuel oil used to operate ORNL equipment
- Fleet Vehicle Operations
- Miscellaneous emissions from research processes and laboratory activities
- Fugitive emissions such as refrigerant leaks

Scope 2 accounts for emissions that are produced elsewhere, but consumed by ORNL operations.

- Currently, the Tennessee Valley Authority (TVA) is the sole source of electricity purchased for all ORNL operations and facilities.

Scope 3 is described as an optional reporting category that allows for the treatment of all other indirect emissions. Included are emissions from activities that ORNL has little control and from equipment we do not own. We studied reports and presentations published by other DOE Labs to determine which of the many indirect activities have been addressed in the past. We expect more guidance from DOE as a result of EO 13514, but for now we followed our fellow Labs and investigated three of the primary Scope 3 activities in this GHG Inventory:

- Employee commute to and from work
- Employee business travel, not conducted in fleet vehicles
- Waste disposition

Notes: Waste Disposition activities at ORNL are classified as Scope 3 because these wastes are disposed of at a DOE Oak Ridge Operations (ORO) facility that is outside of the ORNL operational boundary and outside of our financial control. Wastes generated at ORNL are sent to ORO landfills managed by Bechtel Jacobs. To be inclusive, the sustainable campus team decided to include Waste Dispositions as a Scope 3 activity. After EO 13514 implementations are in place, it is possible that DOE will decide to take ownership of the entire EM Waste facility as a Scope 1 activity; therefore eliminating the need for ORNL to report on this activity as a unique Scope 3 emissions source.

The sustainable campus team decided to exclude the production of purchased materials from the current Scope 3 inventory due to the many unknown factors and unproven emission estimates associated with this activity. However, the implementation of a sustainable purchasing policy is included as one of the sustainable campus Roadmaps because it is recognized that ORNL must use purchasing power to promote environmentally-responsible products and technologies. To validate our decision, EO 13514 directs the GSA to develop factors that can be applied to materials purchased by federal agencies. It is expected that such purchases will be excluded from the Scope 3 agency specific reduction goals until the GSA study is complete.

Step 4: Gather Data for Emission Sources in each Scope

Scope 1 data sources include information from the DOE *EMS4 database* for energy usage and cost. The ORNL Utility Division, F&O Directorate, has developed an efficient and accurate system for keeping and sharing this information. C. Wayne Parker provided high-quality, reliable information for fuels purchased by ORNL. The Federal Automotive Statistical Tool (*FAST database*) is the source of information used for Scope 1 ORNL owned vehicle emissions. The ORNL Logistical Services Division, F&O Directorate, has developed an efficient and accurate system for

keeping and sharing this information. Katherine Settles provided high-quality, reliable information for ORNL fleet vehicles.

Other Scope 1 data (for miscellaneous processes and fugitive emissions) were drawn from a combination of ORNL SAP (Systems, Applications, and Products in Data Processing) and HMMIS (Hazardous Materials Management Information System). These systems provided Ad Hoc reports for our purposes, however, clear agency guidelines and quality procedures for the collection of these data are not in place. A recent DOE “data call” was conducted to validate the Climate Leaders assumptions that these sources represent non-significant emissions. As a result, a quality driven EMS4 database for “Misc. and Other Scope 1” sources is under development.

Scope 2 information was drawn from the DOE *EMS4 database* for energy usage and cost. The ORNL Utility Division, F&O Directorate, has developed an efficient and accurate system for keeping and sharing this information. C. Wayne Parker provided high-quality, reliable information for all electricity purchased by ORNL and used for research & development and facilities & operations. As noted, the single source of purchased electricity for ORNL is TVA.

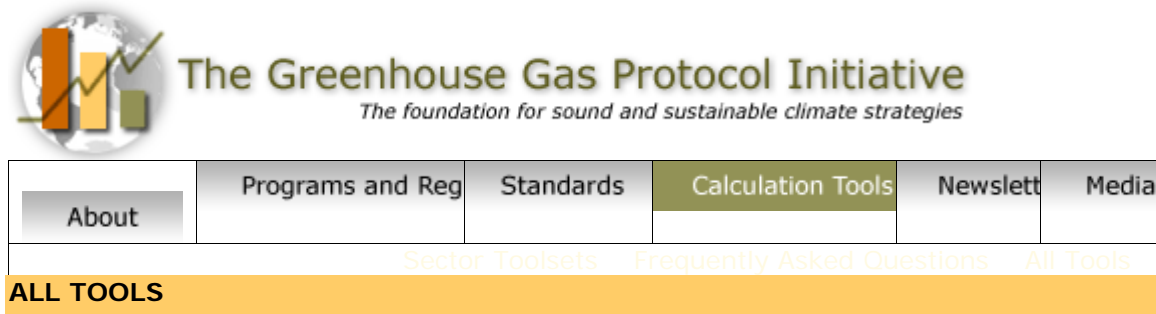
Scope 3 information was drawn from a variety of data sources. By definition, Scope 3 emissions sources result from indirect activities, therefore, many of the data sources and are not directly governed by the organization or parent agency.

- Employee and staff augmentation commute data was obtained by input from ORNL Human Resources (HR) (for UTB direct employees) and from ad hoc reports containing zip code data for employees, subcontractors and visitors with long-term site access (not occasional or one-time visitors). A detailed traffic study, commissioned by the Laboratory Protection Division was used to estimate the total number of vehicles that access the site on an average basis, since employee commute statistics are greatly influenced by human habits.
- Employee business travel information was obtained by means of an SAP report with the input data managed by HR and reported quarterly to DOE. The database segregates domestic and international travel and follows rigorous agency guidelines concerning destinations and travel days. The database lacks detailed information on ground travel after reaching the destination, but otherwise is a good source of reliable data.
- The final Scope 3 activity covered in this report is Waste Disposition activities; information was obtained by Susan Michaud, Environmental Protection & Waste Services Division, ESH&Q Directorate. Due to historical Pollution Prevention concerns both ORNL and DOE provide rigorous guidelines and consistent oversight of this area. Data are collected and reports are produced through the DOE Environmental Management Systems (EMS) databases and are considered very reliable.

Step 5: Decide which Calculations Tools to employ for emission sources in each Scope

As previously noted, the sustainable campus team chose to use the World Resource Institute, Greenhouse Gas Protocol, Public Sector Standard as the guiding document for the development of the FY 2008 calculations. There are a variety of calculations tools employed by WRI; the use of a given tool is dependent upon scope and other factors. The following is a URL and a screenshot of calculation tools available from WRI.

<http://www.ghgprotocol.org/calculation-tools/all-tools>



The Greenhouse Gas Protocol Initiative
The foundation for sound and sustainable climate strategies

About	Programs and Reg	Standards	Calculation Tools	Newslett	Media
Sector Toolsets Frequently Asked Questions All Tools					

ALL TOOLS

Below is a complete listing of all tools provided by the GHG Protocol.

DOWNLOADS

Cross Sector Tools

These tools are applicable to many industries and businesses regardless of sector.

Calculation Tool	Version	Guidance	Worksheet
<i>GHG emissions from stationary combustion</i>	4.0 (Feb 2009)	2 MB	2 MB
<i>GHG emissions from Purchased Electricity, Heat, or Steam</i>	2.1 (Jun 2009)	206 KB	1 MB
<i>GHG emissions from transport or mobile sources</i>	2.0 (Jun 2009)	211 KB	1 MB
<i>Emissions from employee commuting</i>	2.0 (Jun 2006)		179 KB
<i>Measurement and Estimation Uncertainty of GHG Emissions</i>	1.0 (Sep 2003)	227 KB	57 KB
<i>Allocation of Emissions from a Combined Heat and Power (CHP) Plant</i>	1.0 (Sep 2006)	231 KB	50 KB
<i>Emission Factors from Cross-Sector Tools</i>	1.0 (Jul 2009)		227 KB
<i>GHG emissions from refrigeration and air-conditioning</i>	1.0 (Jan 2005)	153 KB	266 KB

After considering WRI and other calculation tools available the following tools were used for each Scope and Source in the ORNL IMP. This table is included in the IMP as shown:

	Emissions Quantification	Calculation Tools	
12.	Quantification Method	<p>A description of the emission quantification methodologies and reference for each emission source and offset project.</p> <p>Where multiple methods are used, specify which facility / source uses the respective method.</p> <p>WRI website with download sources for GHG calculation tools: (live link) http://www.ghgprotocol.org/calculation-tools/all-tools</p>	<p>List the specific calculation tool used for each Source, starting with Scope 1, and show resultant emissions, Scope 1 includes emissions from activities owned or controlled by ORNL and produced onsite.</p> <ul style="list-style-type: none"> • Direct Energy usage such as natural gas and fuel oil used to operate ORNL equipment Source ID S1-001, S1-002: Stationary_combustion_tool.xls • Fleet Vehicle Ops. Source ID S1-003: Mobile -WRI_Transport_Tool.xls • Miscellaneous emissions from research processes and laboratory activities And Fugitive emissions such as refrigerant leaks: hfc-pfc- sf6 tool for minor process sources and fugitive emissions.xls <p>Scope 2 Source ID S2-001 Purchased Electricity: GHG_emissions_from_purchased_energy.xls ORNL ghg-emissions-from-purchased-energy.xls</p> <p>Scope 3 is described as an optional reporting category that allows for the treatment of all other indirect emissions. Included are emissions from activities that ORNL has little control and from equipment we do not own. Primary Scope 3 activities included in the ORNL GHG Inventory:</p> <ul style="list-style-type: none"> • Employee commute to and from work: Employee Commute Calc. Tool.xls • Employee business travel, not conducted in fleet vehicles: Mobile - WRI_Transport_Tool.xls for employee domestic and international Travel • Waste disposition landgem-v302 calc tool.xls from the Landfill Gas Emissions Model (LandGEM) software from EPA: http://www.epa.gov/ttn/catc/products.html#software

Step 6: Calculate Greenhouse Gas Inventory Expressed in CO₂e

Carbon dioxide equivalent (CO₂e) and Global Warming Potential (GWP):

To calculate the total GHG emissions and thus the greenhouse gas inventory of an organization, each gas in the Kyoto protocol has a unique global warming potential. The GWP is a factor describing the radiative forcing impact (degree of impact to the atmosphere) of one unit of a given GHG relative to the basic unit of CO₂.

GWP is calculated over a specific time interval and is most commonly quoted as a 100 year effect. For simplicity of reporting, the mass of each gas emitted is commonly translated into a carbon dioxide equivalent (CO₂e) amount so that the total impact from all sources can be summed to one amount using scientific equivalencies, briefly summarized on the next page of this report. Details of the GWP calculations are governed by The Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body tasked with evaluating the risk of climate change caused by human activity. The panel was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), two organizations of the United Nations. <http://www.ipcc.ch/organization/organization.htm>

The IPCC Fourth Assessment Report (released in 2007) is the source for the following graph and is considered the most current source for GWP factor equivalencies. The next (fifth) assessment is scheduled for release in 2014.

Carbon Dioxide Equivalent (CO₂e):

The emissions of a gas, by mass, multiplied by its "global warming potential."

100-year Global Warming Potential (GWP)

Pollutant	CO₂e Factor
Carbon dioxide (CO ₂)	1
Methane (CH ₄)	25
Nitrous oxide (N ₂ O)	298
Hydrofluorocarbons (HFC)	124 - 14,800
Perfluorocarbons (PFC)	7,390 - 17,200
Sulphur hexafluoride (SF ₆)	22,800

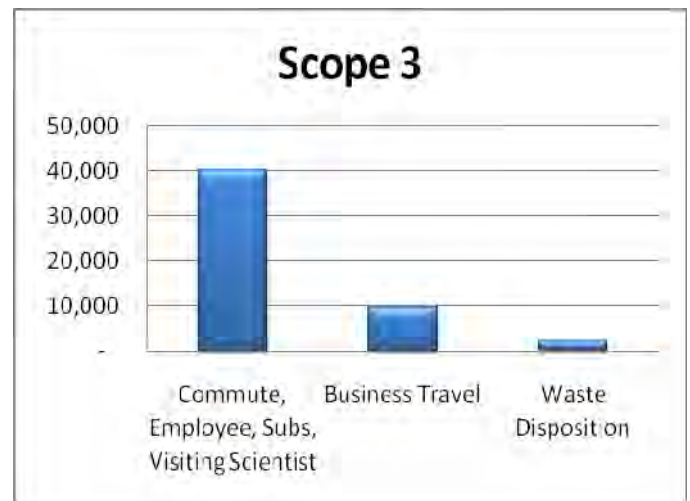
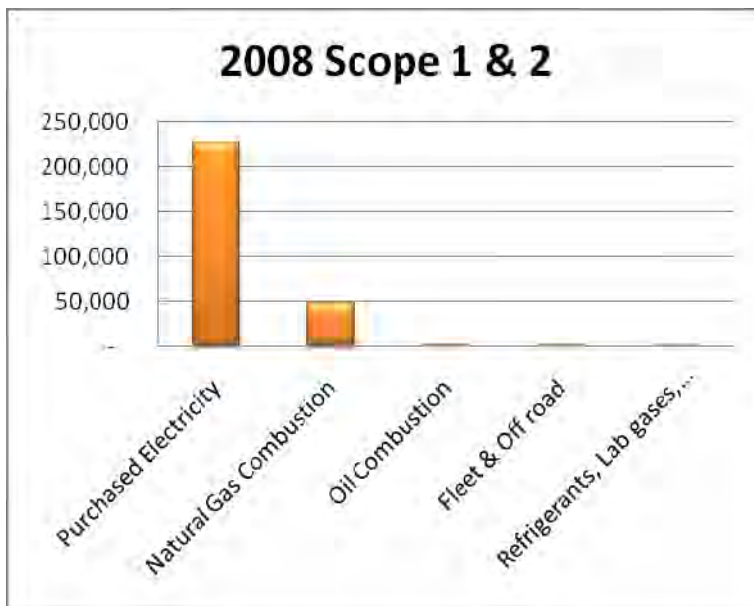
(Source: "Climate Change 2007", IPCC Fourth Assessment Report)

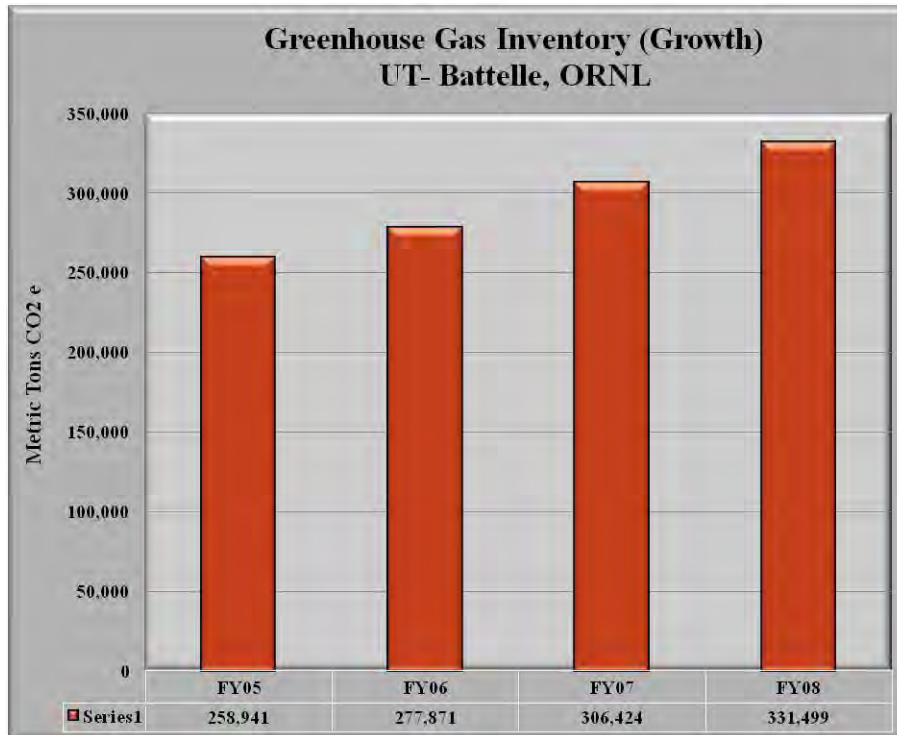
One of the guiding principles of the GHG Protocol is the use of standardized approaches including the reporting of Greenhouse gas inventory calculations in metric tons. All emission sources are calculated using GWP factors and reported in Metric Tons (or metric tonnes) of CO₂e.

Whenever possible, the emissions source information was collected back to FY 2005 to coordinate to and compare with DOE Order 430.2B Objectives (TEAM - Transformational Energy Action Management) and other federal directives and initiatives. For this report, only the FY 2008 Greenhouse Gas Inventory Calculation is shown in detail (see page 13). To show growth and comparisons, total greenhouse gas inventory summary values by federal year are shown on page 14.

Results of greenhouse gas inventory/greenhouse gas emissions using WRI Public Standard and Greenhouse Gas Protocol using calculation tools as described in Step 5 (page 10).

Scope	FY 2008	Metric Tons CO₂e
2	Purchased Electricity	226,010
1	Natural Gas Combustion	47,585
1	Oil Combustion	1,946
1	Fleet & Off road	2,152
1	Refrigerants, Lab gases, fugitive, etc.	1,468
		279,161
3	Commute, Employee, Subs, Visiting Scientist	40,273
3	Business Travel	9,724
3	Waste Disposition	2,341
	Total	331,499



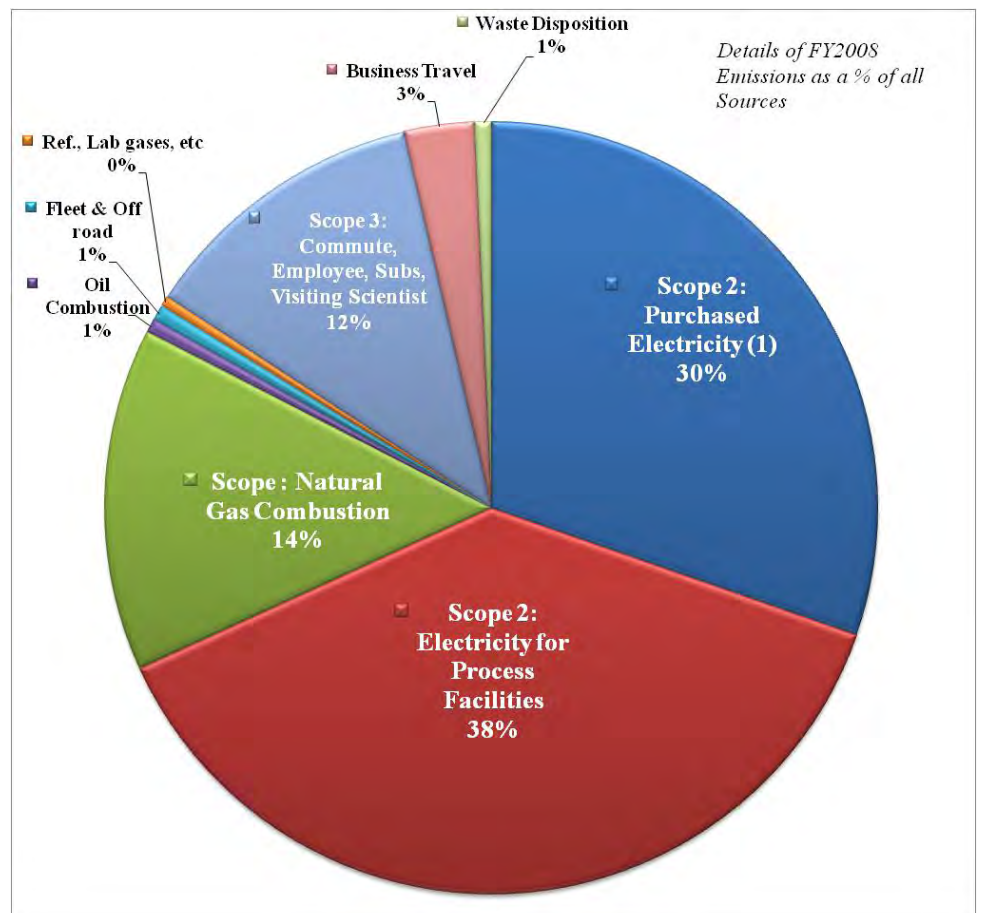


Step 7: Develop meaningful graphical representations of results

To display the results in meaningful and simple terms the sustainable campus team uses graphics representation to demonstrate the results of our analysis. Though this reports covers FY2008 in detail, we studied the increase in greenhouse gas emissions since FY2005. Among other initiatives, ORNL has committed to more research in support of National Security, Energy Sciences, and Climate Change. These programs use energy intensive computer modeling as a means to response to critical national challenges. As a result we continue to grow in research & development, as well as facilities & operations and other divisions.

This pie chart shows the relationship between all sources (for all scopes) of the ORNL emissions for FY2008.

- Scope 1- all sources account for **16%** of total. *See table on page 13 for all scope 1 emissions.*
- Scope 2 – electricity purchased for TVA – accounts of **68%** of the total. This graph shows the comparison between purchases for traditional buildings and process facilities. As the ORNL mission grows, the process facilities will continue to grow to support the new research.
- Scope 3 – the three primary sources of scope 3 emissions account for **16%** of the total. *See table on page 13 for all scope 3 emissions.*



Step 8: Review findings with Sustainable Campus Initiative Management Team and Initiative Champions

The calculations and findings were discussed with the Initiative Management Team, including the F&O Champion, Herb Debban. Detailed PowerPoint presentations were developed and shared with the management team to allow for guidance and discussion. While our greenhouse gas emissions will be difficult to reduce due to research growth and TVA emission factors, an absolute commitment has been granted from management to continue the ORNL Sustainable Campus Initiative as a means to reduce future emissions to the highest degree possible.

This following graph represents the current TVA power mix compared to the national average. TVA is the sole source of purchased electricity (Scope 2 emission sources) for all operations at ORNL and the entire DOE Oak Ridge Operations. Conventional practices dictate that we have limited influence over the emission sources. While it is believed that TVA will make continuing efforts to reduce emissions, it will be necessary for ORNL to consider alternatives such as expanded on-campus renewable power sources in order to obtain substantial near-term reductions in Scope 2 emissions.

Tennessee-TVA Fuel Mix Factors as reported by TVA & EIA (US Energy Information Administration).

	Coal	Nuclear	Hydro	Oil	Gas	Biomass+ win	%	<u>TVA</u> <u>(TN)</u> <u>GHG</u>
2008	61.8	33.0	4.2	0.4	0.6	<0.02	100.0	
2007	63.6	31.0	4.5	0.2	0.6	<0.02	99.9	
2006	65.0	27.1	7.2	0.2	0.5	<0.02	100.0	
2005	61.3	29.6	8.5	0.2	0.5	<0.01	100.0	
2004	60.0	30.3	9.4	0.2	0.2	<0.01	100.0	
2003	60.2	27.2	11.6	0.4	0.7	<0.004	100.1	
2002	62.7	29.8	7.2	0.3	0.0	<0.004	100.0	
7 year average TVA (TN)	62.1	29.7	7.5	0.3	0.4	0	100.0	
National Average	45.3	19.1	7.6	7.1	18.8	2.1	100.0	

Emissions Potential Improvements Scenarios:

- Emissions would be 6% lower if Hydropower makes up 11.6% of the energy mix (as in 2003) vs. 4.2% (as in 2008); if the Hydropower replaces Fossil Fuel powered production
- If the ORNL Power Mix could replicate the National Average, total GHG Emissions would be lower by ~ 12%

Another legitimate concern expressed by the ORNL management team is the inconsistency with the treatment of process and research facilities that support efforts such as National Security. In some executive orders and directives concerning energy management, they are exempt; however, these same facilities are expected to be included in Greenhouse Gas Inventory Calculations and GHG reduction goals.

Step 9: Document Strengths and Weaknesses related to the Greenhouse Gas Inventory Roadmap

Strengths

- Partnership with the World Resource Institute (WRI)
- Quality of purchased electricity data
- Quality of purchased fuel data
- Quality of Fleet Vehicle data

Weaknesses

- Rapidly changing scientific Global Warming Potential (GWP) estimates, and thus rapidly changing calculation tools and factors
- Quality of data for refrigerants, lab gases, fugitive emissions, etc.
- DOE has not yet developed consistent guidelines for indirect emissions (Scope 3)

Step 10: Develop Plans for GHG Management and Reduction Strategies

An emissions management report and Greenhouse Gas Inventory Reduction Strategy Plan are currently under development, to be published in March, 2010. Primary considerations are:

- Follow Federal guideline developments and agency reduction targets set by DOE as a result of EO 13514 Implementation
- Whenever possible, tie reductions back to proactive steps taken by ORNL, including the Sustainable Campus Initiative and it's 22 Roadmaps
- Document results of previous initiatives and project that result in energy savings and conservation, including the ESPC (Johnson's Controls) projects and other ECM projects
- Consider strategic methods to engage power provider (TVA) in emissions reduction plan

An example of the Greenhouse Gas Inventory Performance Indicator (Metrics) for Scope 1 emissions is shown below:

