Argonne National Laboratory

Site SUSTAINABILITY PLAN

December 2011

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Argonne NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

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Site Sustainability Plan

December 2011

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Prepared for U.S. Department of Energy

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List of Acronyms

AMEIS	Advanced Metering and Energy Information System
AFV	alternative-fuel vehicle
AHU	air handling unit
ALCF	Argonne Leadership Computing Facility
AP	accredited professional
APS	Advanced Photon Source
ATLAS	Argonne Tandem Linear Accelerator System
AWA	Argonne Wakefield Accelerator
Btu/GSF	British thermal units per gross square foot
C&D	construction and demolition
CD	critical decision
CEM	certified energy manager
CHP	combined heat and power
CIS	Computing and Information Systems
CMS	Chemical Management System
CNM	Center for Nanoscale Materials
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalent
DEAR	Department of Energy Acquisition Regulation
DOE	U.S. Department of Energy
ECM	energy conservation measures
EIS	energy information system
EISA	Energy Independence and Security Act
EO	executive order
USEPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESB	Energy Sciences building
ESPC	energy savings performance contract
ESQ	Environment, Safety and Quality Assurance Division
FEMP	Federal Energy Management Program
FIMS	Facilities Information Management System
FMS	(Argonne) Facilities Management and Services Division
FY	fiscal year
gal/GSF	gallons per gross square foot
GHG	greenhouse gas
GSA	General Services Administration
GSF	gross square foot
HEMSF	high energy mission specific facilities
HPSB	high-performance sustainable building
HRSG	heat recovery steam generator
HVAC	heating, ventilation, and air conditioning
IGPP	institutional general plant projects
ILA	industrial, landscaping, and agricultural
LED	light-emitting diode
LEED	leadership in energy and environmental design
LOM	laboratory/office module
MR	major repair
MT	metric tons
MWh	megawatt hours
NECPA	National Energy Conservation Policy Act

NREL	National Renewable Energy Laboratory
NO_x	nitrogen oxides
ODS	ozone-depleting substance
P2	pollution prevention
PPA	power purchase agreement
PPOA	pollution prevention opportunity assessment
PUE	power utilization effectiveness
REC	renewable energy credit
ROI	return on investment
SAMM	sub-angstrom microscopy and microanalysis
SAN	sustainability assistance network
SC	DOE Office of Science
SECC	Sustainable Employee Commuting Committee
SF_6	sulfur hexafluoride
SSP	Site Sustainability Plan
SSPP	Strategic Sustainability Performance Plan
TCS	Theory and Computing Sciences
T&D	transmission and distribution
VFD	variable frequency drive
ZGS	Zero Gradient Synchroton

Executive Summary

Argonne National Laboratory is entering into its second performance year under the Site Sustainability Plan (SSP), coming off of a very successful year. This FY2012 SSP documents previous fiscal year accomplishments and outlines Argonne National Laboratory's aggressive strategy to meet the U.S. Department of Energy (DOE) sustainability goals. Argonne continues to make measured, systematic progress towards meeting goals for conserving electricity, reducing greenhouse gas (GHG) emissions, and utilizing green practices in modernizing facility infrastructure, as outlined in the table below.

At the FY2011 end, Scope 1 and 2 GHG emissions were reduced by 16%, in just three years since the baseline year of 2008, towards the 28% planned reduction. A major component of meeting this goal is the reduction of sulfur hexafluoride emissions by nearly 78% since the 2008 baseline year. The goal should be met in advance of the 2020 deadline upon completion of the planned reduction measures. This will mark a major achievement considering the Laboratory is in period of significant growth with five major facilities recently added and the future, near-term startups of the Energy Sciences Building (ESB), and the Advanced Protein Crystallization Facility (APCF). The Advanced Photon Source (APS) upgrade is not expected to result in a significant GHG emissions increase.

The major unknown regarding future GHG emissions remains Argonne's role in High Performance Computing and the associated power and cooling needed to operate these advanced machines. Argonne completed construction and startup of a new Central Chilled Water Plant in FY2011. This plant provides high efficient chillers for the new Blue Gene Q computer. Argonne also completed an engineering study of power and cooling management practices that should be evaluated for exascale computing. The study also kick-started an effort to consolidate data centers and computer rooms at the laboratory into more energy efficient spaces and configurations.

The Laboratory is confident that successes in the area of potable water reduction will continue in future years, further reducing water use and intensity to meet the goal of 26% water intensity reduction by 2020 from a 2007 baseline. Currently, the reduction has reached 23.5% through the end of FY2011, far exceeding near term expectations. This trend will stabilize, but substantial reductions are expected, exceeding the final goal to a degree based on funding availability. Argonne will continue to commit substantial resource towards completing development of the energy information system (EIS) with the installation of additional advanced meters and the continuation of energy dashboard customization. Additional funding commitments will be made towards existing roof replacement with cool roofs with a goal of replacing 25% of existing roofs by the end of FY2015. Also receiving continued focus will be the laboratory fleet vehicle reduction efforts with the goal of reducing the fleet by 35% from the 2005 baseline by the end of FY2013. The Laboratory has also achieved a 20.6% energy intensity reduction, since 2003, toward the 30% energy intensity reduction goal by 2015 in goal-subject buildings.

Argonne has a number of initiatives planned to further reduce energy and greenhouse gas emissions. These include a possible follow on ESPC/UESC for goal-subject buildings, in-house energy projects, the combined heat and power (CHP) plant, steam loss reductions, APS lighting upgrade, building retro-commissioning; energy audits, and facility demolition. One area proving to be more difficult to achieve is the reduction of the Scope 3 GHG emissions, the three larger contributors being emissions from electricity transmission and distribution (T&D) losses, business travel, and employee commuting. A major initiative is underway to reduce employee commuting and business travel GHG emissions that is expected to show results in FY2012.

The Laboratory is committed to the goal of 15% of existing, larger than 5,000 gross square foot buildings, meeting the green building standards by 2015. A 23,675 square foot laboratory office

module (LOM) was upgraded in FY2011 to become Argonne's first retrofitted high performance sustainable building (HPSB). We are evaluating the costs of bringing other LOMs up to HPSB standards as well as designing new "green" facilities. In fact, FY2011 marked another new achievement - Argonne's first Leadership in Energy and Environmental Design (LEED) Gold building - with the certification of the sub-angstrom microscopy and microanalysis (SAAM) building.

Achieving our sustainability goals will require a dedicated, cohesive effort. To better position Argonne, at the outset of FY2012, the sustainability, energy management, and environmental compliance functions at the Laboratory were all reorganized into a new program office to more organically integrate sustainability into day-to-day Argonne operations and R&D. Significant employee outreach activities will continue to create interest, inspire employee-generated ideas, and adopt sustainable behavior and practices.

The table below summarizes Argonne's current progress towards EO goals.

SSP Goal #	DOE Goal	Argonne 2011 Performance Status	Major Planned Actions	Risk of Non-attainment (H,M,L)
1.1	28% Scope 1 & 2 GHG reduction by FY2020 from FY2008 baseline	16% reduction	CHP plant, SF_6 recovery, renewable energy systems, etc.	M
1.2	30% energy intensity reduction by FY2015 from a FY2003 baseline (goal subject buildings only)	20.6% reduction	Site-wide ESPC/UESC, in-house energy projects, CHP, steam loss reductions, Advanced Photon Source (APS) lighting upgrade, building retro-commissioning; energy audits, facility demolition	M
1.3	Individual buildings or processes metering for 90% of electricity (by 10/1/12); for 90% of steam, natural gas, and chilled water (by 10/1/15)	Met – electricity, natural gas, steam Plan to meet – chilled water metering	Continuing development of Energy Information System (EIS); installation of more advanced meters; Chilled water flow rates and inlet/outlet temperatures are metered at many buildings; additional meters will be installed to meet 90%	L
1.4	Cool roofs, unless uneconomical, for roof replacements unless project already has critical decision (CD-2) approval. New roofs must have thermal resistance of at least R-30	Met – only cool roofs specified. 10% of roofs retrofitted	All future new buildings will have cool roofs; at least 25% of existing roofs to be replaced by FY2015	N/A
1.5	7.5% of site's annual electricity consumption from renewable sources by FY2013	Met via REC purchase	Continue REC purchases, installation of small-scale on-site renewable systems, investigation of renewable energy power purchase agreement	H
1.6	10% annual increase in fleet alternative fuel consumption by FY2015 from FY2005 baseline	Met – over 75% increase already achieved	Continued use of alternative-fueled vehicles (AFVs)	N/A
1.7	2% annual reduction in fleet petroleum consumption by FY2020 from FY2005 baseline	Met – over 84% reduction already achieved	Continued use of AFVs, hybrids, and electric vehicles (EVs)	N/A
1.8	75% of light duty vehicle purchases must be AFV by FY2000	Met – all purchases are AFVs	Continued acquisition of AFVs as fleet changeover occurs	N/A

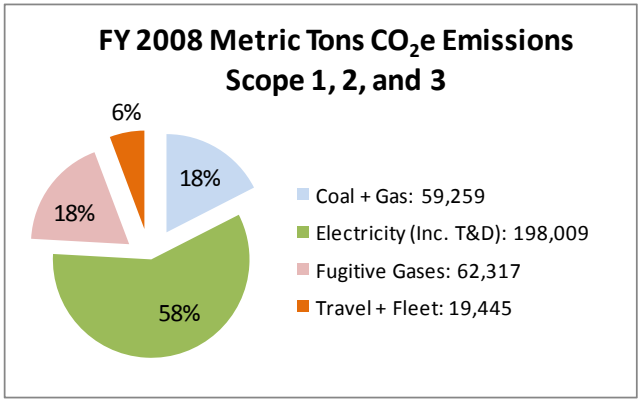
SSP Goal #	DOE Goal	Argonne 2011 Performance Status	Major Planned Actions	Risk of Non-attainment (H,M,L)
1.9	Reduce fleet inventory by 35% within the next 3 years relative to a FY2005 baseline	Plan to meet – complete comprehensive fleet review	Complete 30% reduction by the end of FY2012 and final 5% reduction by the end of FY2013	M
2.1	13% Scope 3 GHG reduction by FY2020 from a FY2008 baseline	0.2% reduction – increase in number of employees limited planned reductions	Expand use of videoconferencing; establish comprehensive sustainable employee commute strategy; better tracking of commuting alternatives and behavior	H
3.1	15% of existing buildings larger than 5,000 gross square feet (GSF) to be compliant with the five guiding principles of HPSB by FY2015	Plan to meet – 5% of existing buildings comply with Guiding Principles	Continue focus on Laboratory Office Modules (LOMs) at APS and evaluate additional building for HPSB feasibility	H
3.2	All new construction and major renovations greater than $5 million to be LEED® Gold	All new buildings designed to meet LEED Gold	All new buildings to meet or exceed	L
4.1	26% water intensity reduction by FY2020 from a FY2007 baseline.	At 23.5% reduction through FY2011	Water recycling, installation of low-flow fixtures	L
4.2	20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY2020 from a FY2010 baseline	Plan to meet – reduced ILA water by 2.4% exceeding the target reduction of 2% per year	Cooling water recycling; continued use of native landscaping	L
5.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition material and debris by FY2015	Met – Diverted 53% of non-hazardous solid waste	Continue detailed tracking pollution prevention processes.	L
5.2	Divert at least 50% of construction and demolition material and debris by FY2015	Plan to meet - Diverted 40% of construction material	Continue detailed tracking pollution prevention processes	L
6.1	Procurements meet sustainability requirements and include sustainable acquisition clause (95% year)	Met – sustainable acquisition clauses included in contracts	Sustainable acquisition clause is integrated into Argonne's Terms and Conditions for all contracts	L
7.1	All data centers are metered to measure monthly power utilization effectiveness (PUE) (100% by FY2015)	Plan to meet	All data centers, except those scheduled to be phased out by FY2014, will have dedicated electrical metering by the end of FY2012	L
7.2	Maximum annual weighted average PUE of 1.4 by FY2015	Plan to meet – utilize data collected by dedicated meters to meet PUE requirement	Evaluate data center consolidation plans to address PUE requirement	M
7.3	Electronic Stewardship – 100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY2012	Plan to meet – currently all PCs in operations areas managed using management software	Plan to complete PC power management system deployment efforts initiated in FY2011	L

1.0 Introduction

Argonne Green Lab Initiative

Turning Ideas into Action

Argonne's FY2008 carbon baseline is 339,030 metric tons. Purchased power (both direct emissions and transmission losses) represents 58% of this footprint. Fugitive emissions (primarily sulfur hexafluoride - SF_6) comprise the next largest component at 18%. Coal and natural gas combustion for steam production is approximately 18%. The remaining 6% is related to transportation, most of which is attributable to employee commuting and business air travel.



Argonne is developing strategies and taking actions to meet or exceed all Executive Order (EO) goals. In EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance, President Obama called on Federal agencies to set a shining example of sustainability for the rest of the nation by improving environmental, energy, and economic performance, and to achieve targeted reductions in our greenhouse gas (GHG) emissions by 2020. The highest risk/opportunity areas are affordable on-site renewable energy, energy intensity, and growth of high energy mission specific facilities (HEMSF).

Through FY2011, Argonne achieved a 20.6% energy intensity reduction for goal-subject buildings. However, considerable funding ramp-up is required to meet the 30% FY2015 goal. Finally, the highest risk lies in our growth potential. Power demands are expected to double or triple in the next seven years as Argonne builds out exascale computing facilities. Although these facilities are exempt from energy intensity requirements, meeting GHG reduction goals will require innovative clean or renewable energy solutions.

Argonne's Site Sustainability Program is divided into five key focus areas:

- Transportation
- Energy and Water Conservation
- Renewable and Clean Energy
- Pollution Prevention (P2)
- Employee Involvement

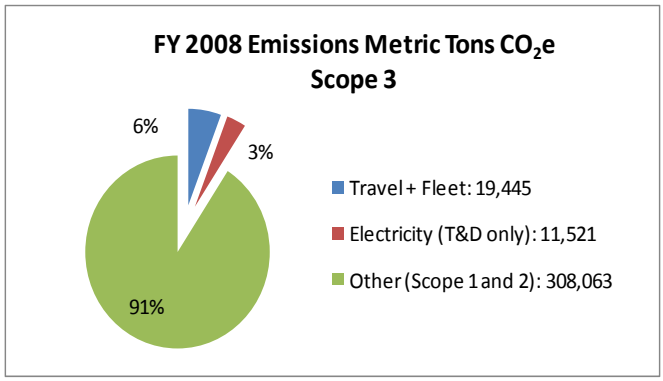
The laboratory developed overall goals within each focus area that support EO 13514 goals and Argonne's commitment towards a sustainable campus. Major strategies and actions were then developed that when executed, provide the means for goal achievement.

Focus Area 1 – Transportation

Goals and Strategies (Table 1-1)

1. Green the fleet
   a. Cut petroleum use by 2% annually
   b. Changeover to alternative-fueled vehicles

2. Promote a healthy work environment by facilitating walking and biking.



3. Cut emissions from employee transportation by 15%
   a. Facilitate carpooling and low-emission vehicles
   b. Reduce carbon footprint from employee business travel

Table 1-1: Transportation Strategies

Action	Plan	Status	GHG Reductions (Metric tons)
Lease and purchase electric vehicles	Maximize leasing as vehicles become available through General Services Administration (GSA).	Purchased four small "Neighborhood" electric vehicles in FY2011 for a total of nine electric vehicles for on-site use	20
Reduce emissions from medium and heavy duty vehicles	Monitor industry developments; switch to biodiesel mixes.	Various ethanol/diesel fuel mixes being introduced	70
Lease hybrid vehicles	Add 10 more hybrids to fleet in next two years	Six (6) hybrids added to fleet in FY2011	25
Expand Bike Share program	Continue Bike Share Program and partnership with Chicago Transportation Alliance	Fleet size increased to 120 bicycles and 1,500 participants in FY2011	50
Improve biking conditions	Continue considering safe bike travel when planning road-resurfacing projects.	19% of paved roads widened, continue to evaluate additional road widening for safer bike use	N/A
Encourage walking and biking	Continue participation in Active for Life competition and "Bike to Work" weeks	Continue promotion of joint sustainability / employee wellness activities	N/A
Expand use of videoconferencing	Evaluate current use and capabilities; develop plan to expand services and use	Installed additional video conferencing centers; will continue in FY2012	310
Promote use of high efficiency vehicles and ride sharing	Create mechanism for reporting and promoting use of high- efficiency vehicles and car pooling	Developed customized "GreenRide Connect" Ride Share Application, plan to launch in FY2012	1,700[1]
Telecommuting	Promote telecommuting once a week, when practical	Benefits and impact on GHG Scope 3 calculated	830
		Total Target Reduction	>3,000

[1] The Laboratory assumes there will savings in employee commute emissions from greater availability, government mandates, and market forces for high-fuel-efficiency vehicles.

Focus Area 2 – Energy and Water Conservation

Water Conservation Goal and Strategies (Table 1-2)

1. Reduce potable water use 26% by 2020 (from 2007 baseline)
2. Reduce industrial water use 20% by 2020 (from 2010 baseline)
3. Maximize use of recycled water

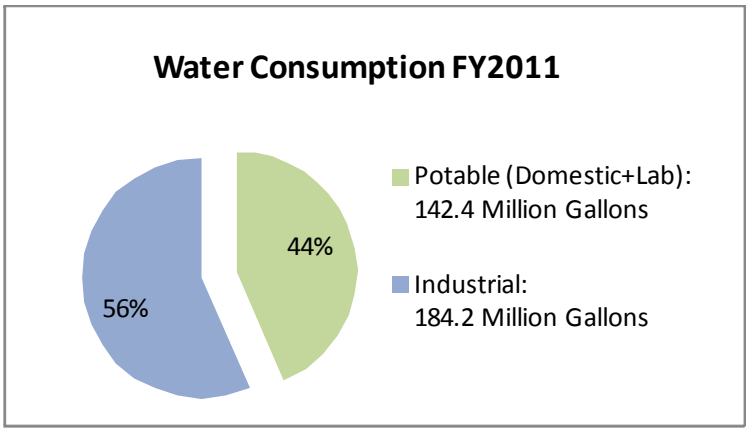


Table 1-2: Water Conservation Strategies

Action	Plan	Status	Water Reduction (million gal)
Use low-flow fixtures	Continue specifying for all new facility and renovations	Additional fixtures replaced in FY2011	6
Repair or replace steam traps (external leaks)	Expand program to build steam traps; evaluate use of real time monitoring tied to campus building automation system	FY2011, site-wide survey completed with 62 defective steam traps replaced in seven buildings	10
Recycle cooling water	Eliminate additional once- through cooling water by adding systems to a central chilled-water loop or through other water recycling methods	FY2011 connected cooling water systems of four buildings to closed loop chilled water system	57
Implement tighter water chemistry and blowdown control	Reduce industrial makeup water needs through better water chemistry and reduced blowdown cycles	Begin evaluation in FY2012	18.5
		Total Target Reduction	91.5

Green Building Goals and Strategies (Table 1-3)

1. Ensure 15% of buildings greater than 5,000 sq. ft. meet high-performance sustainable building (HPSB) guiding principles by FY2015

2. Construct all new buildings over $5 million to meet Leadership in Energy and Environmental Design (LEED) Gold certification or greater

3. Meet HPSB guiding principles for new construction under $5 million

4. Effectively consolidate operations and research to maximize cold shutdown of older buildings as new, energy-efficient buildings come on line.

Current no. of buildings over 5,000 sq. ft.	73
Total no. of buildings over 5,000 sq. ft. (FY2015)	76
15% requirement (no. of buildings)	12
Current no. of buildings meeting requirement	4
Additional buildings needed	8

Table 1-3: Green Building Strategies and Progress

Action	FY	Criteria	Status	Building Count
Existing Buildings				
Shipping and Receiving Building	2010	LEED Silver	Currently meets criteria	1
Sub-Angstrom Microscopy and Microanalysis (SAMM) facility	2011	LEED Gold	Currently meets criteria	1
Laboratory Office Modules (LOMs)	2015	HPSB	Completed feasibility study in FY2011; LOM 438 retrofit completed (meets HPSB principles)	3 - 6
Center for Nanoscale Materials (CNM)	2011	LEED Silver	LEED certified; LEED Silver certification pending	1
New Construction (>$5 mil)				
Energy Sciences Building (ESB)	2013	LEED Gold	LEED assessment completed; construction underway and on target	1
Advanced Protein Crystallization Facility (APCF)	2014	LEED Gold	Conceptual planning underway	1
Advanced Photon Source (APS) – Early Assembly Building	2015	LEED Gold	Conceptual planning underway	1
APS – Long Beamline	2015	LEED Gold	Conceptual planning underway	1
New Construction (<$5 mil)				
Central Chilled Water Plant	2011	HPSB or LEED	Construction completed; compiling LEED documentation for submittal	1
Combined Heat and Power (CHP) Plant	2013	LEED Silver	Conceptual design phase	1
Total Target Reduction				12 -15

Electricity Intensity Goals and Strategies (Table 1-4)

1. Reduce energy intensity 30% in goal-subject buildings by 2015
2. Reduce energy use 20% in excluded facilities to facilitate GHG reduction by 2020
3. Reinvest utility cost savings in additional energy projects
4. Create a platform for intelligent building and data center management

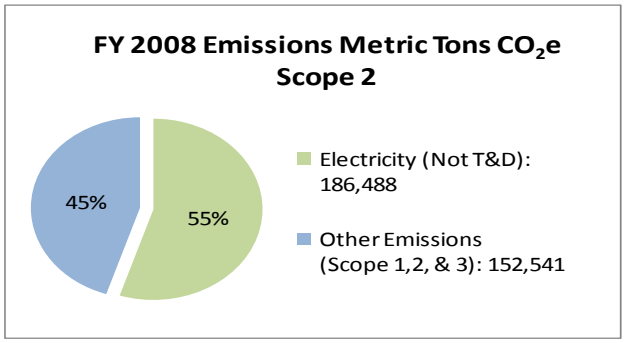


Table 1-4: Electricity Intensity Reduction Strategies

Action/Area	Plan	Status	GHG Reductions (Metric tons)
Site-wide Award Energy Savings Performance Contract (ESPC) #5 / Utility Energy Savings Contract (UESC)	Start project in FY2012 for FY2013 award	Evaluating energy conservation measures (ECMs) requiring larger capital investment; target $5 to $10 million investment	4,000
ESPC #4	Build CHP plant. Initiated in FY2010; plant expected to be constructed in FY2013	Preliminary assessment phase underway. Electricity is generated as a by-product; purchased electricity will drop significantly	34,100
In-house energy savings program	Complete 10 to 15 projects annually based on return on investment (ROI)	Completed 17 projects in FY2011 at cost of $1,021k; FY2012 program funded at $522k	900
Consolidate data centers	Consolidated location to be chosen in FY2012	Consolidation study completed	TBD
Energy reduction software for desktops	Implement PC Power Management software site-wide	Phase I of project deployed during FY2011; continue in FY2012	150
Install advanced metering	Upgrade metering to optimize building and data centers operations	Phase I of project initiated in FY2011 at cost of $750k; continue installation of campus-wide advanced metering system	3,000
Cool roofs	Continue cool/white roof changeover	~15% of retrofits completed; additional 10% planned by FY2015	300
		Total Target Reduction	>42,000

Steam Reduction Goals and Strategies (Table 1-5)

1. Support energy intensity goals through efficient steam generation
2. Incorporate use of renewable fuel for steam production
3. Minimize losses in condensate lines and steam traps
4. Minimize heat loss in buildings and install heat recovery systems

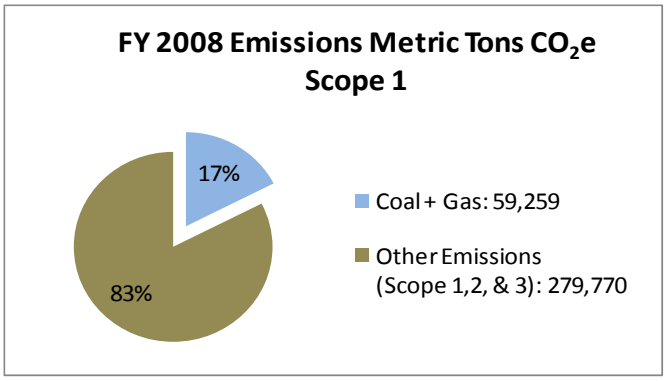


Table 1-5: Steam Reduction Strategies			
Action	**Plan**	**Status**	**GHG Reductions (metric tons)**
Build CHP plant	New ESPC initiated in FY2010. Plant expected to be constructed in FY2013[2]	Preliminary assessment phase underway	35,000
Replace insulation on steam piping	Replace insulation to reduce thermal losses	Insulation replaced at five locations	40
Survey and replace dysfunctional steam traps	Expand program to building steam traps; evaluate use of real-time monitoring tied to Metasys®[3]	62 steam traps were replaced in FY2011 (Phase III) – continuing program in FY2012	200
Develop geothermal energy systems with heat recovery	Evaluate heat recovery systems on large power users such as APS and high performance computing centers	Engineering studies completed, project documented -- pursuing funding strategies	840
		Total Target Reduction	36,080

[2] Note: Many of the projects included in the electricity, steam or water savings tables will have savings in both areas. For simplicity, projects are listed in the table where the majority of savings are expected.

[3] Argonne uses the Johnson Controls, Inc., Metasys® as its buildings' automation and control system.

Focus Area 3 - Renewable and Clean Energy

Goals and Strategies (Table 1-6)

1. Meet or exceed 7.5% renewable energy production
2. Develop large-scale clean energy approaches to support exascale computing and other scientific program growth
3. Purchase renewable energy credits (RECs) to promote renewable energy technology

Table 1-6: Renewable and Clean Energy

Action	Plan	Status	GHG Displacement (metric tons)
Develop bio-fuel combustion capability	Continue efforts to use bio-fuel in solid fuel boiler and/or new CHP plant.	Renewable fuel market was cost-prohibitive in FY2011, re-evaluate in FY2012 based on National Renewable Energy Laboratory (NREL) assessment update	5,000
Create mid-scale renewable energy capability	Evaluate on-site and off-site (within region) wind power feasibility	Argonne was awarded a U.S. Department of Energy (DOE) contract to research off-shore super-conducting wind turbines, plan to conduct mid-scale on-site wind power study in FY2012	15,000
Purchase RECs	Purchase credits to meet balance of goal versus on-site production	Purchases made in FY2011 for 7.8% of electrical power use, continue to purchase RECs in FY2012 to meet goal	14,700
Small wind turbine	Install 10 kW wind turbine on-site	Feasibility study completed. Expected to be installed in FY2012	10
Fuel cells	Install 400 kW system at bldg 440, pending funding	Feasibility study completed. Since the cost estimate is higher than originally anticipated, ESPC or UESC financing mechanisms are being considered.	1,000
Ground source heat pumps	Complete installation of geothermal heat pump at building 224	Complete building 224 geothermal heat pump system in early FY2012, consider other on-site applications based on performance of installed system	35
Large-scale solar photovoltaic array (10 MW)	Evaluate the potential for large-scale solar to offset programmatic growth	Explored power purchase agreements (PPA) financing, current 10-year contract duration not favorable for third parties	9,800
Small-scale solar systems	Continue evaluation of small-scale solar to provide building and electric vehicle power	Solar PV panel EV charging station installed in FY2011; selected site for 75 kW solar farm to be installed in FY2012, continue to evaluate more capacity in the future	285
Develop large-scale clean or renewable energy source	Continue to explore PPAs or potential on-site or nearby project	Worked with regional renewable energy firm in FY2011 to evaluate off-site PPA for GHG reduction credit; pursue next steps in FY2012	TBD
		Total Target Reduction	>45,000

Focus Area 4 – Pollution Prevention

Goals and Strategies (Table 1-7)

1. Reduce SF_6 emissions by 90% from FY2008 levels
2. Insert sustainability requirements in 95% of contracts
3. Use established P2 program to support sustainability goals
4. Divert at least 50% of non-hazardous solid-waste construction and demolition (C&D) debris from landfills by FY2015

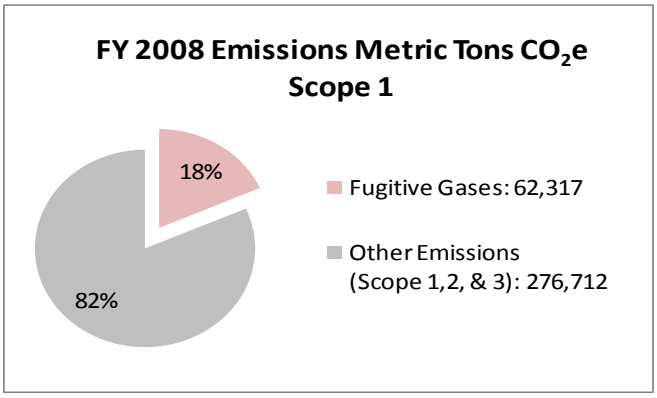


Table 1-7: Pollution Prevention Strategies

Action	Plan	Status	GHG Reductions (metric tons)
Capture SF_6 fugitive emissions	Operate leak detection and recovery systems on all sources by FY2013	Reclamation systems at the Wakefield Accelerator and APS will become operational in early FY2012; continue to formalize leak detection and recovery program in FY2012	54,000
Sustainable acquisition	Incorporate sustainable acquisition (Department of Energy Acquisition Regulation (DEAR) 970.5223-7) into all new contracts beginning January 1, 2012	Evaluated impacts of adding sustainable acquisition DEAR 970.5223-7 into procurement procedures and policies in FY2011	N/A
Pollution prevention	Continue Pollution Prevention Opportunity Assessment Program (PPOA)	Completed four PPOAs in FY 2011 and will continue in FY2012 by completing four additional PPOAs	TBD
Waste reduction	Numerous events and activities are planned; see Table 2-11 for details	See Table 2-11	N/A
		Total Target Reduction	54,000

Focus Area 5 – Employee Awareness

Goal and Strategies (Table 1-8)

- Engage entire workforce in meeting sustainability goals
  a. Use programmatic researchers for sustainability planning
  b. Encourage "sustainable" personal behavior by all employees

- Actively promote sustainability as a core value and program
  a. Create and execute a long-term communication plan
  b. Demonstrate senior leadership commitment
  c. Include sustainability considerations in budget decisions and project selection
  d. Integrate sustainability program into environmental management system (EMS)

Table 1-8: Employee Awareness Strategies

Action	Plan	Status
Strategic Transformation Teams	Use programmatic scientists and engineers to develop transformative ideas for campus GHG reduction	Teams are set up and actively generating proposals
Sustainability Communications Plan	Develop multi-faceted plan to communicate Argonne program and solicit involvement	Communications plan, entitled - "Green Lab Initiative: Ideas into Action," completed. Routine internal and external communications were developed
GHG Footprint Reduction Contest	Start intra-division and intra-building contests for GHG reduction	Conducted Car'gonne Challenge, a contest designed to decrease GHGs resulting from employee commuting
Sustainability WebPage	Capture sustainability program efforts in new web page for internal and external access	Green Lab Initiative web site was completed in FY2011 and continues to be updated Initiated the Sustainability Idea Exchange, which gives employees a place to submit, discuss, and vote on ideas for reducing greenhouse gas emissions and saving energy and water
Sustainability Training	Expand integration of sustainability concepts into employee awareness training	Continue to integrate sustainability concepts and practices into employee training
GHG and EO Goal Visibility	Integrate building-specific metering data into energy/GHG "dashboards"	Team formed, initial concept for dashboards developed; funding allocated, and building-specific dashboard templates developed and deployed in FY2011 for development of campus energy information system (EIS)

Summary

Table 1-9 below summarizes Argonne's initial GHG reduction target of over 37%. Additional details on these strategies and actions are provided in Section 2, Goal Performance Review and Plans.

Table 1-9: Major Strategic Initiative Summary			
Focus Area	**FY2008 Emissions (MT CO_2e)**	**SSP Reductions (MT CO_2e)**	**Overall GHG Target Reduction (percent)**
Transportation (Scope 1 and 3)	19,445	2,578	13.3
Steam Production (Gas and Coal)	59,259	36,300	61.2
Electricity (Scope 1 and 3)	198,009	20,450	10.3
Fugitive Emissions (F-Gases, Landfill, and Wastewater)	62,317	54,036	86.7
Renewable and Clean Energy	0	13,987 (credit)	7.5
Total	339,030	127,351	37.5

Section 2 provides more detail on these initiatives per the required DOE template. Table 1-10 provides a crosswalk of EO 13514 and DOE Strategic Sustainability Performance Plan (SSPP) components to Argonne's Sustainability Program focus areas:

Table 1-10: Executive Order/SSPP Component	
Focus Area	**Executive Order/SSPP Component**
Transportation	Petroleum Use Reduction for Fleet Vehicles Alternative-Fuel Vehicles for Fleet Use Employee Business Travel (Air and Ground) Employee Commuting
Energy and Water Conservation	Energy Intensity Cool/White Roofs Potable Water Reduction Industrial Water Reduction Data Center Efficiency Metering LEED/HPSB for New Construction/Major Renovation Guiding Principles for Existing Buildings
Renewable and Clean Energy	On-Site Renewable Electricity Use Increase Renewable Energy Consumption GHG Reductions
Pollution Prevention	Electronics Stewardship Pollution Prevention and Waste Elimination Sustainable Acquisition SF_6 Emissions Reduction Storm Water Management
Employee Involvement	Training Site Innovation Regional and Local Planning Comprehensive GHG Inventory

2.0 Goal Performance Review and Plans

2.1 Scope 1 and 2 Greenhouse Gas Reduction

2.1.1 Energy Intensity Reduction

The energy intensity reduction goal is 30% by the end of FY2015, relative to FY2003 baseline, for goal-subject buildings (Figure 2-1). A depiction of the FY2008 electricity usage and resultant CO_{2e} contribution is included as Figure 2-2.

2.1.1.1 Performance Status

Seventeen energy and water conservation measures were completed in FY2011 and several started in FY2011 will continue in FY2012. While Argonne has concentrated efforts in goal-subject buildings, work has been performed throughout the campus because of the laboratory's commitment to energy savings and to a smaller carbon footprint.

About 64% of total site electricity use (see Figure 2-3) has been consumed by four HEMSF (see Section 5 for more details). Due to the high percentage of buildings with power loads driven by scientific equipment, only about 34% of Argonne's overall electricity is used by goal-subject buildings. Argonne is on track with meeting energy intensity goals for goal-subject buildings. In FY2011, the energy intensity ratio was reduced by 20.6%, versus a targeted 20.0% (see Figure 2-1). Overall power consumption (both goal subject and goal excluded) is shown in Figure 2-3.

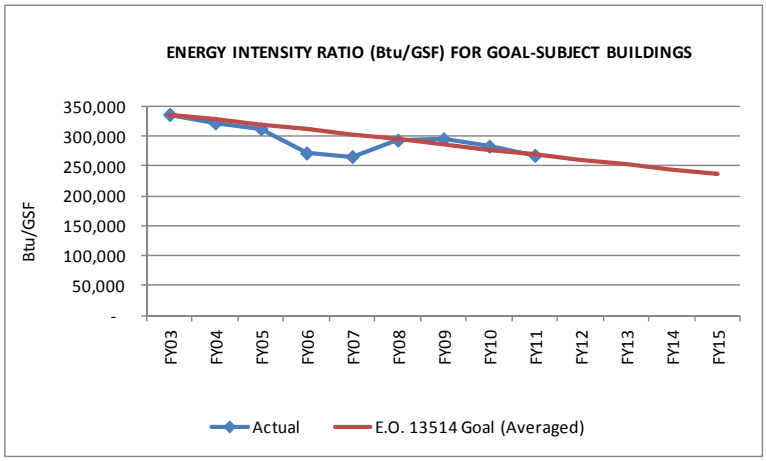


Figure 2-1: Energy Intensity Ratio

Argonne's Proactive Energy Management System for Buildings

Argonne has successfully launched BuildingIQ's energy management system at the APS 401 office building. The building has a total floor space area of 100,000 sq. ft. and around 300 occupants. The office space is conditioned by two central air-handling units. BuildingIQ's system makes use of weather forecast information and building temperature predictions to optimize, in real-time, the air delivery conditions of the air-handling units. In addition, the system makes use of occupant comfort models to ensure appropriate comfort conditions at all times. Finally, BuildingIQ's system can obtain real-time information directly from the occupants to assess their current comfort status. This is key since comfort is a subjective measure that depends on many factors.

After three months of deployment, the system has been able to achieve reductions in the total electricity demand of the air-handling units in the range of 20-40%. The system is capable of dropping energy demand both during occupied and unoccupied times. The ability to exploit ambient air to minimize the load of the air-handling units is one the main factors driving the savings. In addition, the ability to add flexibility of the average temperature inside the building while maintaining comfort provides significant energy savings opportunities. Data shows that comfort perception does not change within a relatively wide band of temperature allowing for non-perceived energy savings.

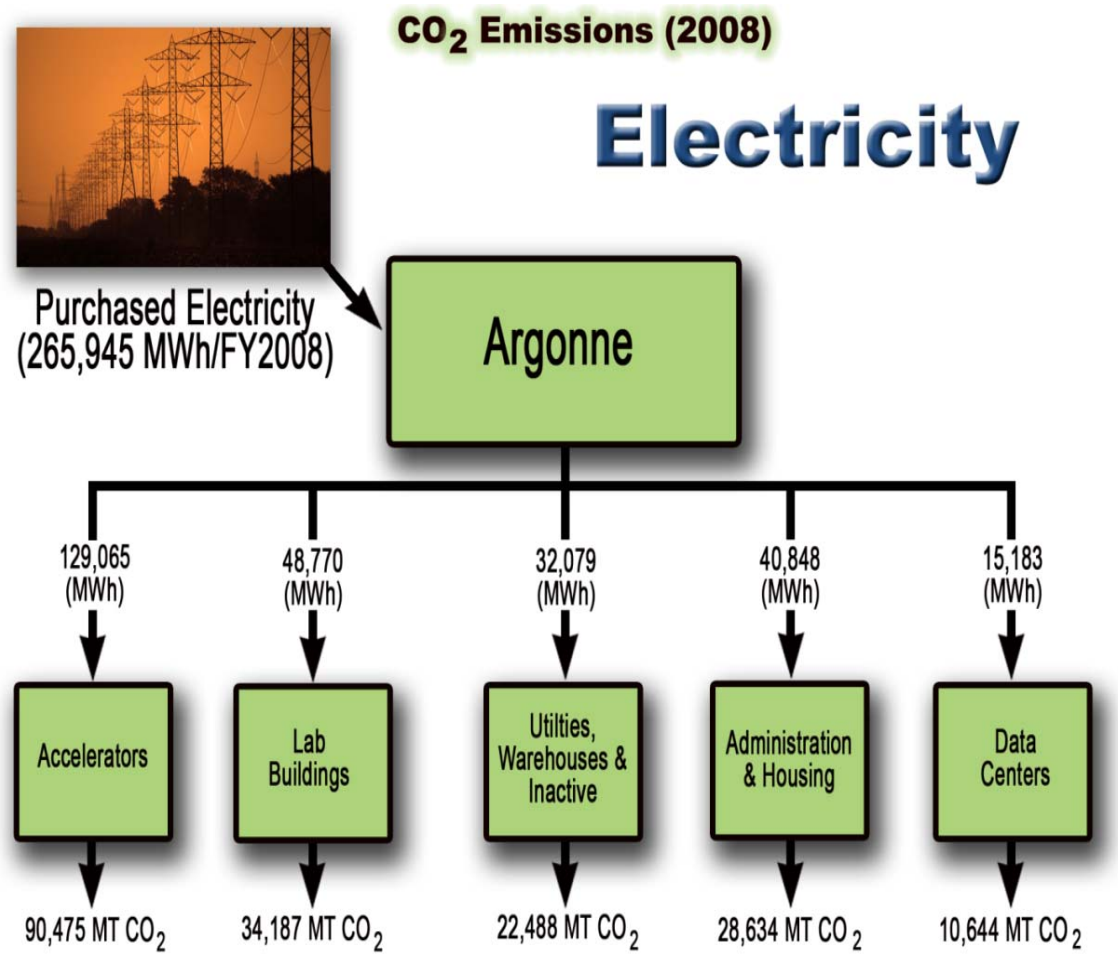


Figure 2-2: Electricity Usage at Argonne National Laboratory

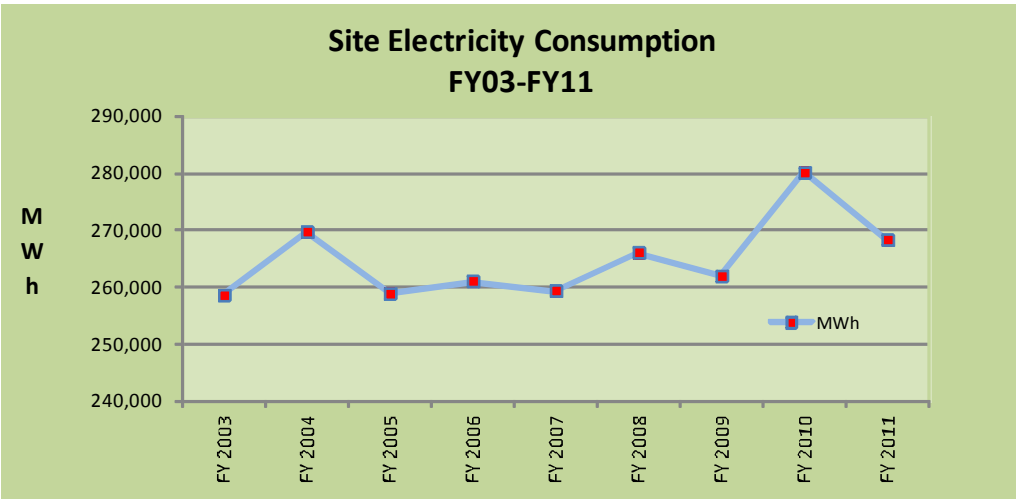


Figure 2-3: Site Electricity Consumption per Fiscal Year

Argonne achieved these reductions through two major strategic programs: 1) Three ESPCs and 2) the in-house Energy Savings Reinvestment Program. Argonne has successfully utilized ESPC contracting for several years. Table 2-1 shows the energy conservation measures, energy savings, and cost savings from the laboratory's three current ESPC projects.

Table 2-1: Energy Conservation Measures, Energy Savings, and Cost Savings

ESPC 1	Energy Savings (MBtu/yr)	Cost Savings($/yr)
Building 201 – Upgrade Controls	1,040	$45,243
Building 350 – Reduce Unoccupied Outside Air	8,867	$57,267
Buildings 314/315/316 Lighting Upgrade	810	$13,839
Building 350 Lighting System Upgrade	719	$13,186
Upgrade Steam Pipe Insulation	28,808	$193,560
Building 315 VFD Installation on S-3 System	2,938	$21,141
	43,182	**$344,235**
ESPC 2		
Coal Fired Boiler Upgrade	19,197	$595,785
ZGS Area Chiller Replacement	4,374	$80,550
FMS Extended Architecture Upgrade	48	$37,079
APS Storage Ring Heat Recovery	9,845	$82,676
300 Series Buildings – Lighting Improvements	3,356	$60,647
200 Series Buildings – Lighting Improvements	9,193	$177,953
Building 200 K Wing Window Replacement	55	$873
Site-wide Condensate Return Improvements	6,306	$68,290
APS Storage Ring Pumps/VFDs	6,830	$122,819
	59,204	**$1,226,670**
ESPC 3		
APS Free Cooling and Metasys Upgrade	7,984	$179,417
APS Experimental Hall AHU Modifications	14,738	$141,502
APS LOM AHU Heat Reclamation	7,251	$68,194
APS Lighting Upgrades	1,646	$36,995
APS Lighting Controls Upgrade	1,677	$37,683
	33,296	**$463,791**
Grand Total ESPC	**135,682**	**$2,034,696**

In late FY2008, Argonne created an in-house Energy Savings Reinvestment Program initiative to complement the ESPC program. Under this initiative, the laboratory's maintenance foremen and engineering team identify, evaluate, and prioritize energy conservation projects. Projects are completed using Argonne infrastructure mechanics or small contracts to achieve quick savings. Savings are verified and reported to Argonne's Office of the Chief Financial Officer which, in turn, provides recurring funding equivalent to the amount of utility cost savings. This funding is then reinvested in additional energy savings projects.

By the end of FY2011, the program had generated over $521,000 in annual savings. Seventeen energy and water projects were completed site-wide in FY2011. These projects included interior and exterior light fixtures and lighting controls upgrades, insulating steam

FY2011 Project Energy, Water, and Cost Savings for In-house Program

Electricity Savings	4,490,604 kW/yr
Natural Gas Savings	4,717 MBtu/yr
Water Savings	39,544 KGal/yr
Steam Savings	28,231 MBtu/yr
Cost Savings	$521,633/yr

piping, repairing condensate returns, installation of occupancy sensors, installation of light emitted diode (LED) and light emitted capacitor (LEC) types of exit signs, replacing poorly functioning steam traps, as well as conversion from once-through cooling by potable water to closed loop chilled water system(s). Image 2-1 shows a team from Oklahoma State University conducting a lighting assessment, which helped inform lighting upgrade strategies.

Table 2-2 provides a summary of completed in-house energy and water projects.

Image 2-1: Oklahoma State University Team Conducting a Lighting Survey in FY2011

Table 2-2: In-house Energy and Water Projects

Date Applied	Project Title	Electricity Savings (kW/yr)	Natural Gas Savings (MBtu/yr)	Water Savings (kgal/yr)	Steam Savings (MBtu/yr)	Total Current Annual Savings ($)
Oct-2008	Boiler House VFD Installation	90,000				$6,903.00
Oct-2008	Boiler House Air Compressor Installation	35,808				$2,746.47
Oct-2008	Building 203 Cooling Tower Project	138,963				$10,658.45
Apr-2009	Exit Sign Installation First Half FY2009	14,437				$1,107.35
Apr-2009	Building 201 Conference Room Dimmer Panel	405				$248.78
Apr-2009	Building 366 Lighting Upgrade	210,240				$16,125.41
Oct-2009	Tower 42 Heating System			2,304	16,751	$141,973.00
Oct-2009	Buildings 314-316 Condensate Return			910	884	$10,128.30
Oct-2009	Building 201 Condensate Return			137	133	$1,521.54
Oct-2009	Exit Sign Installation Second Half FY2009	46,100				$3,535.87
Oct-2009	Building 369 Lighting Upgrade	217,268				$16,664.45
Oct-2009	Building 364 Pump VFD	360,945				$27,684.46
Oct-2010	Building 214 HVAC Unit Replacement	41,874				$3,211.72
Oct-2010	Building 214 Install Occupancy Sensors	10,982				$842.35
Oct-2010	Building 213 HVAC Controls Upgrade	277,966			3,000	$50,000.00

Table 2-2: (Cont.)						
Date Applied	Project Title	Electricity Savings (kW/yr)	Natural Gas Savings (MBtu/yr)	Water Savings (kgal/yr)	Steam Savings (MBtu/yr)	Total Current Annual Savings ($)
Oct-2010	Cooling Tower Modernization	664,875				$50,995.91
Oct-2010	LED Emer Exit Lights - Phase 3 (bldgs 200, 202, 203)	77,025				$5,907.81
Oct-2010	Replace T-12 with T5 Lamps in high bays 362	96,290				$7,385.44
Oct-2010	Replace T-12 with T5 Lamps in high bays 370	270,544				$20,750.71
Oct-2010	Replace T-12 with T5 Lamps in high bays 371	108,379				$8,312.67
Oct-2010	Exterior Lights-entrance	4,555				$349.38
Oct-2010	Replace Air Compressor	176,272				$13,520.06
Oct-2010	Cooling Tower Replacement 350	24,600				$1,886.82
Oct-2010	Metasys Sensors	860.16				$65.97
Oct-2010	Heat exchanger bypass	258,263				$19,808.80
Oct-2010	Upgrade lighting in cooling tower Building 450	46,253				$3,547.59
Oct-2011	Site-wide once-through to closed-loop cooling			29,315		74,754.29
Oct-2011	Lighting upgrade with controls	122,640				$6,622.56
Oct-2011	Site-wide: Exit lights replacement with LEC	34,909				$1,885.09
Oct-2011	Insulate steam piping		610.28			$3,051.41
Oct-2011	Steam traps repair and replacement		3,324.75	363		$17,549.00
Oct-2011	Repair condensate return		781.88	853		$6,085.34
Oct-2011	High bay lights replacement	129,263				$6,980.20
Oct-2011	High bay light replacement	141,772				$7,655.68
Oct-2011	Lights replacement	264,289				$14,271.62
Oct-2011	Lights replacement	139,309				$7,522.69
Oct-2011	Solar photovoltaic panel	3,892				$210.17
Oct-2011	Lighting upgrade	96,290				$5,199.66
Oct-2011	Occupancy sensors in corridor	269,107				$14,531.78
Oct-2011	Replace high bay light fixtures and lamps	58,377				$3,152.36
Oct-2011	Replace high bay light fixtures and lamps	4,336				$234.14
Oct-2011	Parking lot lighting upgrade (handicapped spaces)	9,167				$495.04
Oct-2011	Parking lot lighting upgrade (general spaces)	5,623				$303.63
Total All		4,490,604	4,717	39,544	28,231	**$521,633**

The efforts in FY2011 have not gone unnoticed. The Argonne Sustainability Program and core team individuals were presented the following awards in FY2011:

- U. S. Energy Secretary Steven Chu recognized the Fugitive Emissions Working Group (FEWG), of which Argonne National Laboratory is a part, with the Secretary's Achievement Award, the DOE's highest nonmonetary honor for a group or team effort. Gregory Barrett, Environmental Engineer, accepted the award on behalf of Argonne National Laboratory and all Argonne employees who contributed to the laboratory's sulfur hexafluoride (SF6) reduction efforts.
- Michael Dunn, Deputy Division Director, was featured as a 2011 Federal Energy and Water Management Awards recipient and a 2011 DOE Sustainability Awards recipient.
- Argonne was presented with the 25th Annual Governor's Sustainability Award for 2011 for its commitment to improving health and sustainability of the State of Illinois.

2.1.1.2 Planned Actions

The major planned energy intensity reduction project is a new CHP plant. Conceptual design is complete and the ESPC planning and contracting process is underway. This will be ESPC Delivery Order #4, planned for completion in FY2014.

The CHP plant will be the main source of steam for the campus, with the capability to produce 5.8 MW of electricity as a by-product. The project will reduce Argonne's carbon footprint by 13% (Scope 1 and 2 - over 35,000 metric tons; based on 2008 baseline), and will reduce emissions of nitrogen oxides, sulfur dioxide and other air pollutants. The CHP is also projected to provide 8.4% of the overall 30% site-wide energy reduction required for goal-subject buildings.

Energy savings opportunities were identified during a five-day investigation phase of retrocommissioning, performed by a third party (FEMP contractor) in FY2011. Buildings 200, 203, 205, 212, and 362 were evaluated. Argonne also hired Rockwell Engineering to do an energy audit of the steam plant and four other major buildings A list of final recommendations is being reviewed for potential projects in FY2012 and beyond, through either ESPC #5 or a UESC. Several promising measures have been identified; however, these ECMs need a closer look to verify adequate payback on investment. Lighting upgrades at APS and consolidation of data centers are planned as well..

Argonne plans to continue its Steam Trap Upgrade Program under its Reinvestment Program. Most of the main outdoor traps were replaced since FY2009 (62 in FY2011 only). However, there are hundreds of traps inside buildings, many of which are in disrepair. Other major steam system projects include a steam plant energy audit and evaluation of heat recovery systems. The Facilities Management and Services Division (FMS)-Utility Systems Department also has several upgrades and efforts planned using their own mechanics and operators that can provide substantial steam savings:

- Replacing carbon rings in the turbines on forced-draft fans to reduce steam losses.
- Replacing steam control valves on three forced-draft fans. The turbines now rotate at about 900 rpm constantly with the fan vanes nearly completely closed. More desirable is for the turbines to rotate at about 400-500 rpm with the fan vanes 40 to 60% open.
- Improving the monitoring and control of boiler blowdown to balance scale reduction, energy savings, water savings, and water treatment chemical cost savings.
- Rehabilitating the steam turbine for the #2 Feed Water Pump.
- Replacing the pneumatic damper drives for two forced-draft fans that are experiencing excessive compressed air losses.
- Conducting vibration monitoring and laser alignment of rotating equipment to improve efficiency.

A recent workshop with building engineers and maintenance foremen identified many potential sustainability projects as part of its Energy Savings Reinvestment Program. Based on the energy workshop, Argonne selected the projects listed in Table 2-3.

Table 2-3: Reinvestment Program Projects for FY2012			
Project Description	Estimated Annual Savings ($k/yr)	Implementation Cost Estimate ($k)	Simple Payback Period (yr)
Plumbing fixtures upgrade (bldg 440)	0.2	5.0	24.9
Occupancy sensors (site-wide)	4.2	25.0	6.0
Heat exchanger upgrade (bldg 223)	7.9	50.0	6.3
Insulate high pressure steam piping	3.6	25.0	7.0
Steam traps survey and replacement	10.0	50.0	5.0
Once-through cooling to closed-loop	20.0	20.0	1.0
Cooling tower blowdown (two towers)	4.0	20.0	5.0
Geothermal Heat Pump (bldg 224)	38.0	390.0	10.3

2.1.2 Increase Renewable Energy Consumption

The renewable energy consumption goal is to achieve 7.5% of the site's annual electricity consumption from renewable sources. A double credit for the savings can be taken if the energy is produced on-site.

2.1.2.1 Performance Status

Argonne is currently meeting the on-site renewable energy goals through purchase of RECs (see Section 6.3, Purchasing Renewal Energy Credits). The laboratory also met the requirement to have one renewable energy generating system on-site. In 2008, the NREL completed a renewable energy assessment of Argonne. Although biomass fuel was cited as the most promising of all renewable energy resources, wind and solar energies were also suggested as possible applications.

Solar Photovoltaic (PV) Systems

The 2008 NREL assessment recommended five sites: buildings 46, 21, 223, 440, and 450, as being best suited for roof-mounted solar arrays. At the time of the assessment, these systems were extremely cost-prohibitive. In FY2011, a 3 kW PV electric vehicle charging station was installed near building 212 that can produce enough power to charge four electric vehicles. The system is also grid-tied, when the system is generating surplus power the electricity can be returned to the building for use and inversely, building power can charge vehicles on days when the solar resource is low (see Image 2-2).

In addition, , an engineering study that evaluates ground-mounted PV systems at the Argonne site was completed in FY2011. Three sites were evaluated based on shading, topography, obstructions, nearby utility connectivity, and total cost. The site at the northeast corner of Southwood Drive and Rock Road in the building 360 NW parking lot was determined to be the best location. Total array area would be about 100 by 200 feet and will provide renewable energy to the building 372 Emergency Operations Center.

Image 2-2: Solar Powered Vehicle Charging Station

Wind Turbine Systems

The southwest quadrant of the Argonne campus was identified by NREL as the area best suited for wind turbines. Wind turbines were evaluated as having long payback periods; however, with the double credit for on-site renewable energy production, a case can be made for the pursuit of this technology. NREL also evaluated the feasibility of installing roof-mounted wind turbines but these were deemed as not feasible with the current technology.

Argonne's research sponsor communicated the need to perform smart grid research in conjunction with an on-site wind turbine system, making the case stronger for consideration. The laboratory met with vendors to forward the discussions on the feasibility of installing a small to medium-scale ground-mounted wind turbine system at the site. Also, a group of students from the Illinois State University (ISU)/ Center for Renewable Energy worked on-site to perform a wind resource assessment in the East Area using a Sonic Detection and Ranging (SODAR) system (see Image 2-3). SODAR uses the Doppler effect, by sending out a sound signal and measuring the shift in the frequency of the returned signal. The SODAR system measures wind speed and direction from a height of 20 to 200 meters.

Image 2-3: SODAR System Collecting Data in the East Area

The Sustainability Program also contracted a local renewable energy firm to perform wind energy assessment utilizing the ISU SODAR data and on-site meteorological tower data that informed the site selection, design, and the environmental impact review.. The East Area was selected as the best candidate site of three evaluated because of the site's unobstructed access to prevailing winds, the natural topography, and access to nearby building that could utilize generated power.

The best possible small-scale deployment was found to be a wind turbine model rated at 10 kW installed on a single 100-120 foot tower. The Sustainability Program communicated the conceptual plan with internal and external stakeholders, including a presentation to the Community Leaders Roundtable and the DuPage County Forest Preserve district as a courtesy. If authorized to proceed, the project is expected to be initiated and completed in FY2012.

Geothermal Heat Pump System

Installation of a geothermal heat pump system in building 224 was initiated in FY2011. Building 224 is the welcome center for all of Argonne's visitors and issues on-site gate passes. It is also used as a meeting and outreach space. The existing natural gas heating and air conditioning (HVAC) system will be completely replaced with the Smart Geothermal Heat Pump HVAC System. It is comprised of six, approximately 4-inch boreholes each extending to a depth of approximately 650 feet. Each borehole contains a 1-inch pipe that that conveys the heat transfer fluid in a closed loop system. (See Images 2-4 and 2-5.)

The Smart Geothermal system will eliminate 100% of on-site fossil fuel combustion (natural gas) used for building 224 heat. Based on current utility consumption trends, 668 million Btu (647,600 standard ft^3) of natural gas will be saved per year. This is the equivalent of roughly 78,100 lb of carbon dioxide per year. Once online, the electricity consumption will increase slightly due to the fact that geothermal heating utilizes pumps powered by electricity. It is expected that the system will be fully operational in FY2012.

Image 2-4: Installed 650-foot Deep Geothermal Borehole

Image 2-5: Geothermal System Heat Transfer Fluid Manifold

Biomass for Steam Production

Preliminary work has been done to evaluate use of biomass for steam production. A series of production-scale test burns was performed in FY2009 using wood and agricultural by-product pellets mixed with coal. Although both biomass mixes posed challenges with respect to their handling, the emissions results were positive. Due to its location in the Chicago metro area, Argonne continues to be unable to find an affordable, large-scale biofuel source.

2.1.2.2 Planned Actions

Funding requests will be made in FY2012, to continue to deploy renewable energy systems to exploit on-site solar, wind, and geothermal resources. Also being considered is the feasibility of other clean energy systems such as installation of fuel cells. A more detailed description of each near term renewable / clean energy project is included below.

Solar Photovoltaic (PV) Systems

In FY2012, a 75 kW ground-mounted solar PV array will be installed at the northeast corner of Southwood Drive and Rock Road in the building 360 NW parking lot, in the area shown in Image 2-6. Total array area would be about 100 by 200 feet and will provide renewable energy to the Building 372 Emergency Operations Center. Renewable energy will generated, metered, and served up via a web-based energy dashboard to communicate real-time energy production and GHG savings. The project is expected to generate approximately 105 MWh per year and save 280 MT (618,032 Lbm) of CO_{2e}. This will represent only 0.04% of annual electricity consumption and 1% of renewable energy target; however, it will provide valuable data regarding the correlations between insulation and efficiency, temperature and efficiency, and probe degradation rates under midwest conditions. The project will evaluate three different PV technologies (c-Si, p-Si, and CdTe modules). The data collected will help in determining which technology would be most suitable for a potential larger array in the future. Investing in three different technologies now will enable a highly informed decision on a larger future investment and enable modeling validation.

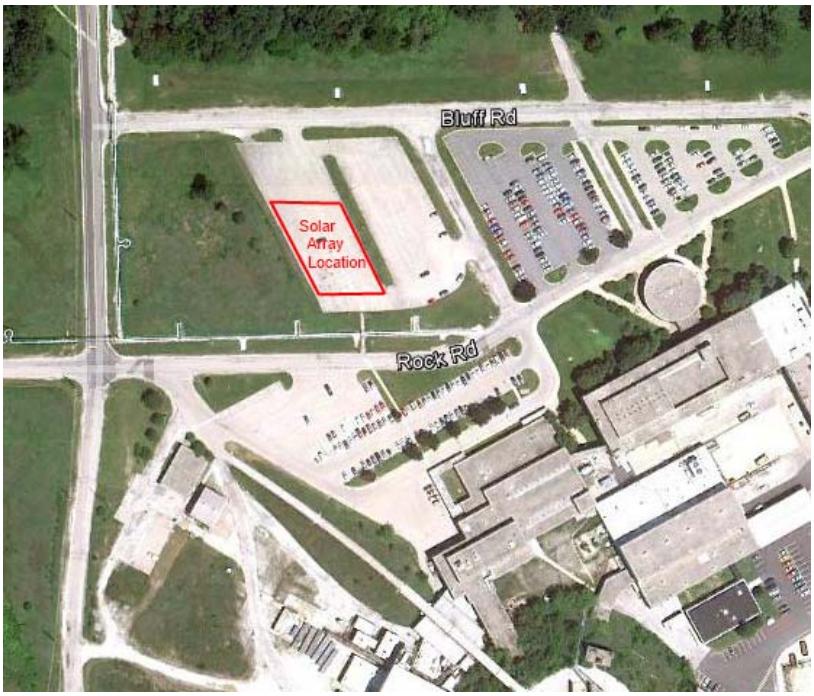


Image 2-6: Proposed 75 kW Solar Photovoltaic Location

Wind Turbine Systems

In FY2012, upon final authorization and funding approval, a small wind turbine system will be installed in the East Area, placed as shown in Image 2-6. Prominent, unobstructed southwest winds, nearby utility connection, measured shadow flicker, and cautionary fall-down distance led to choosing a site in the East Area south of building 46 as the best location. Argonne is considering a 100 to 120 foot hub height, 7 meter (23 ft) diameter, 10 kW wind turbine designed for high reliability, low maintenance, and automatic operation in adverse weather conditions.

When installed, it will be grid-connected to building 46. Renewable energy will generated, metered, and served up via a web-based energy dashboard to communicate real-time energy production and GHG savings. The project is expected to generate approximately 15 MWh per year and save 10.5 MT (23,067 Lbm) of CO_{2e}. This will represent only 0.001% of annual electricity consumption and 0.15% of the renewable energy target; however, it will provide valuable data regarding real time changes in power with different wind conditions, a cumulative performance table, and research for smart grid technology including the addition of wind power to the local microgrid. The system can also become a test bed for energy storage research and will offer a platform to do a broad range of research from grid technology to environmental studies.

2.1.3 Reduce Departmental Fleet Petroleum Annual Usage by 2% and Increase Alternative Fuel Annual Usage by 10%

The EO requires the laboratory to reduce fleet petroleum usage by 2% annually for carbon fuels and increase the alternative fuel usage by 10% annually from a 2005 baseline.

2.1.3.1 Performance Status

Figure 2-4 shows the breakdown of fuel use and associated emissions for FY2008 and Figure 2-5 shows the fuel consumption for FY2005 through FY2011. Argonne has met and exceeded all goals related to fleet transportation. A FY2009 internal review found the agency-owned fleet vehicles at Argonne had an average age of 17 years, with a total annual repair cost of over $200,000. Since that time, Argonne has completely replaced its fleet with one that is entirely GSA-leased. The fleet manager has also introduced smaller and more fuel-efficient vehicles, including:

- 16 new compact and subcompact sedans
- 11 hybrid electric vehicles
- Nine 100% electric “Neighborhood” vehicles. Additional dedicated charging stations were also installed to enhance the convenience of charging these vehicles. The stations have electricity-use tracking capabilities through the site-wide METASYS™ system.

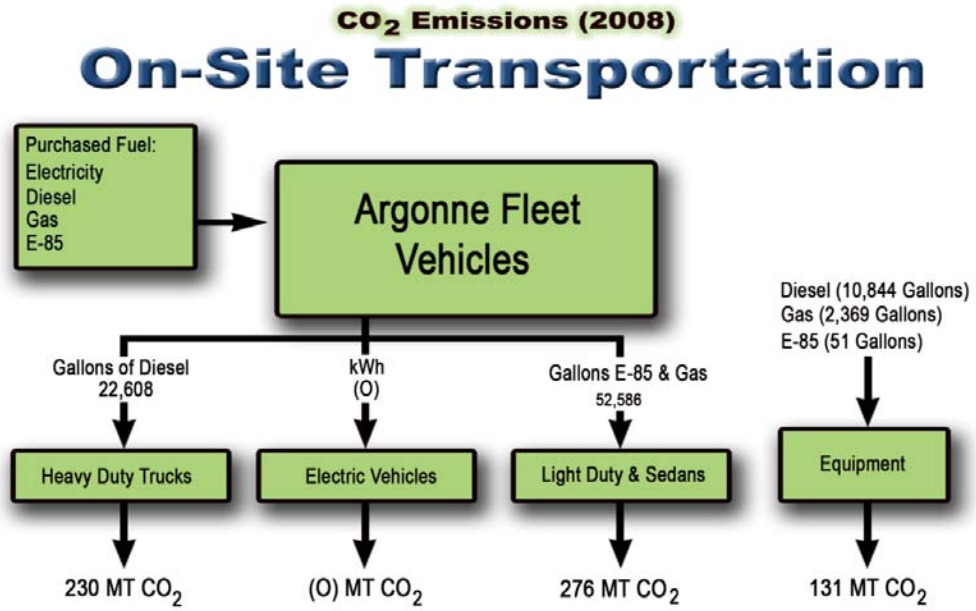


Figure 2-4: On-site Transportation Emissions

These actions have contributed to an 80% petroleum reduction in fuel use and a 75% alternative-fuel increase, greatly exceeding EO goals (see Figure 2-5).

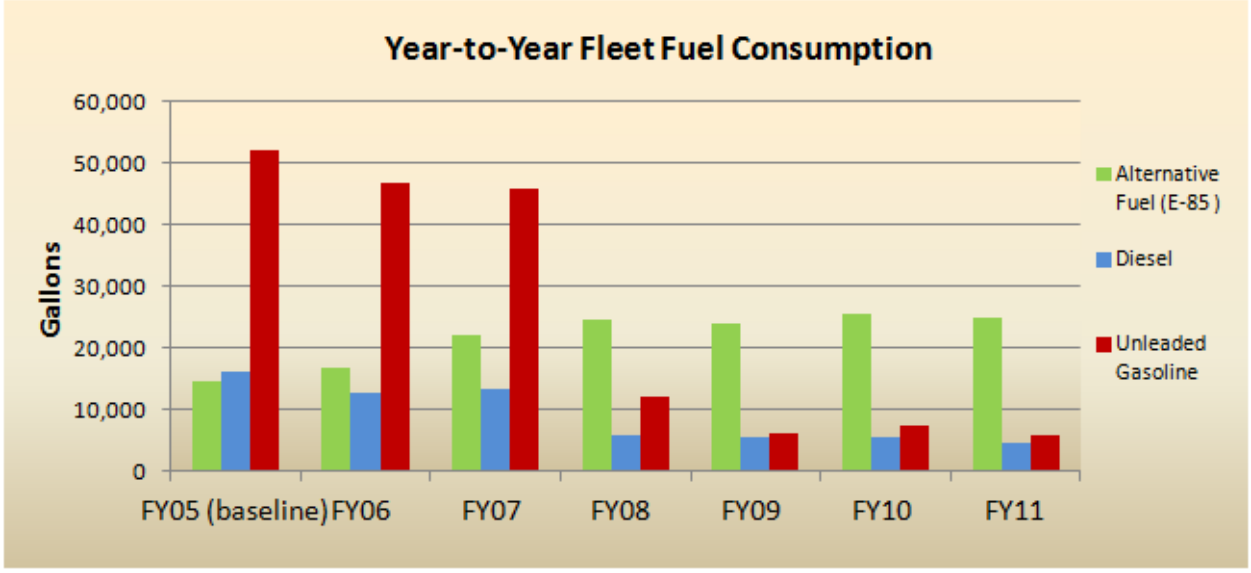


Figure 2-5: FY2005 to FY2011 Fuel Consumption

2.1.3.2 Planned Actions

Planned actions for continued progress include:

- Complete a comprehensive review of the Argonne fleet and prepare a plan to address the DOE goal of a 35% fleet reduction (based on an FY2005 baseline) by the end of FY2013 and the interim goals of a 15% reduction by the end of CY2011, another 15% reduction by the end of CY2012, and a final 5% reduction by the end of FY2013.
- Continue installation of electric charging stations throughout the laboratory for neighborhood electric vehicle use.
- Continue to evaluate the use of bio-diesel mixes in FY2012. Argonne utilized B-20 diesel fuel between April and November of 2011. Due to the concern of B-20 fuel gelling in cold temperatures, B-5 fuels will be used during the winter months.
- Evaluate the further expansion of preferred parking for energy-efficient and/or electric vehicles (see Image 2-7).

Image 2-7: Photo of Tracking Solar PV Electric Vehicle Charging Station and Green Fleet

2.1.4 Metering

EO 13514 requires advanced metering for electricity by 2012 and advanced metering for steam and natural gas by 2016 to the maximum extent practicable. Standard billing level metering is required for water.

2.1.4.1 Performance Status

Previously, plant engineers surveyed all existing electric meters and metering systems. The survey showed a number of advanced meters had been installed on more recent construction and renovation sites. However, with the exception of one building, the advanced meters were not tied into an information system that provided real-time reporting and display of the data. The results from this survey were used to generate a proposal for development of an EIS to collect, trend, and report both the advanced and standard electric meter data throughout the campus.

The survey also showed that there are 38 natural gas meters employed at various building locations and at the central steam plant. Domestic, laboratory, and canal water are metered using 145 meters; 97 of which have remote-reading capability. Steam consumption is monitored by 34 remote-reading meters. Chilled water metering consists of flow meters and temperature sensors in and out for the central plant (371) and buildings 200, 202, 203, 205, 212, 221, and 223. Buildings 211 and 222 also have chilled water temperature sensors in and out, but no flow meters.

Previously, Argonne completed integration of the site-wide building automation system (i.e., Johnson Controls Metasys® system) with the metering and monitoring of mechanical and electrical systems in building 214. The work included lighting, dimming, occupancy sensors, and daylight harvesting for eight offices. The Metasys® system allows real-time and historic building utilities usage to be displayed on a computer monitor in various formats, such as Excel spreadsheets, 3-D charts, or trending graphs.

In FY2011, Argonne initiated a project to install an Advanced Metering and Energy Information System (AMEIS). Application servers and database servers were installed, configured, and programmed to remotely collect interval data from various sources into one central database. Dashboards were developed for visualization of the energy data (Image 2-8). The dashboards will enable effective site-wide communication regarding energy issues and will be used as a tool to educate the laboratory community of the status of progress towards meeting energy reduction goals.

Thirteen switchgear (480 volt) were installed in the 2009 – 2010 time frame (see Image 2-9). Meters on each of the associated main breakers are Ethernet-ready and are capable of collecting interval data for energy and power. Likewise, trip units on all of the associated feeder breakers are capable of collecting interval data for energy and power. In FY2011, Argonne installed network drops to three of these switchgear to enable remote reporting of the data. As shutdowns can be scheduled, this process will be repeated for additional switchgear in the future.

Thirty-five switchgear (480 volt) were installed in the 1990s. Meters on the main and on the feeders are capable of collecting interval data for energy and power. In FY2011, Argonne installed network drops and ethernet gateways for two of these switchgear to enable remote reporting of the data. As shutdowns can be scheduled, this process will be repeated for additional switchgear in the future.

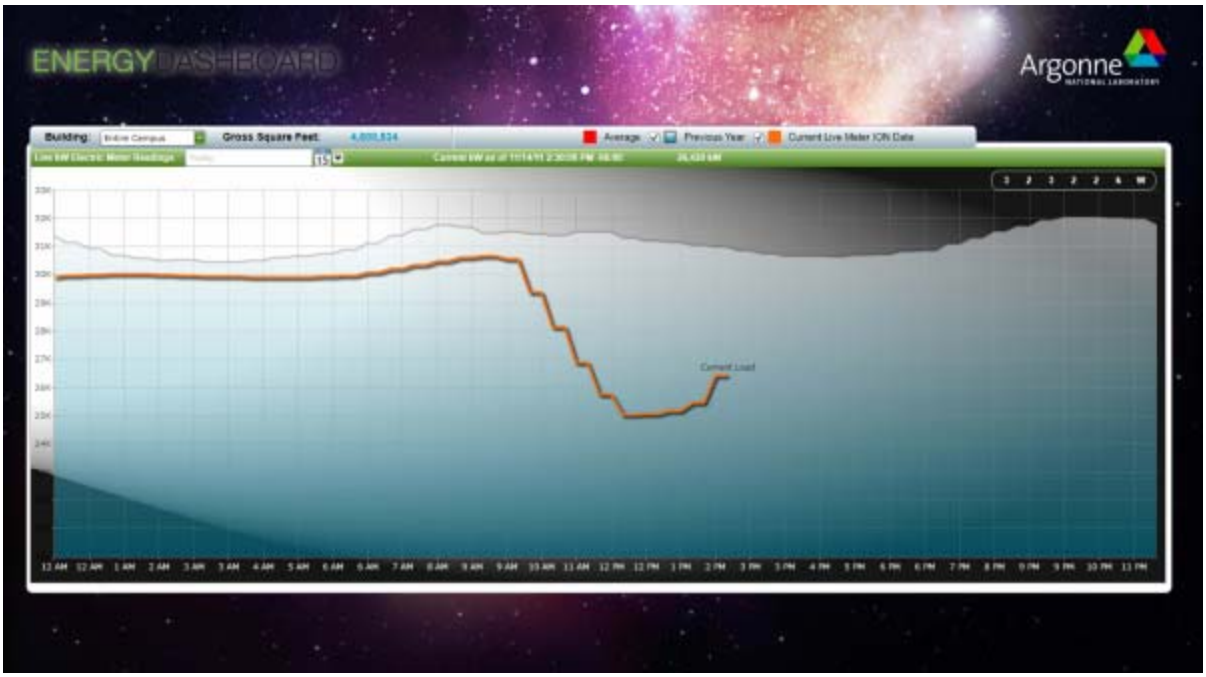


Image 2-8: Screenshot of AMEIS Dashboard for Monitoring Electricity Consumption

Image 2-9: New Ethernet-Enabled Switchgear Meters in Building 212

Thirty-six switchgear (480 volt) were installed during APS construction. In FY2011, Argonne replaced the main meter with an ethernet ready meter and installed meters on the feeders in six of the switchgear to enable remote reporting of interval data. As shutdowns can be scheduled, this process will be repeated for additional switchgear in the future.

Approximately 40 switchgear (480 volt) pre-date the 1990s. Interval kWh data is available for several of these via the site-wide building automation system. Argonne plans to re-commission the kWh data collection system to improve the quality of this data.

2.1.4.2 Planned Actions

Argonne continues to develop a campus wide EIS by continuing to team FMS and Computing and Information Systems (CIS) Division personnel with Building Technologies Program researchers. Planned action in FY2012 includes the following:

- In building 212, several switchgear power supplies, ethernet gateways, and other network infrastructure will be installed to establish communications back to the low voltage SCADA server. Main and the feeder meters, trip units, and circuit breakers will also be configured and programmed into the SCADA system.
- In buildings 400, 401, and 420, the main meters will be replaced and several switchgear power supplies, ethernet gateways, and other network infrastructure will be installed to establish communications back to the low voltage SCADA server. Main and the feeder meters, trip units, and circuit breakers will also be configured and programmed into the SCADA system.

2.1.5 Cool/White Roofs

Cool roofs are roofs that have high solar reflectance and thermal emittance. Cool roofs reduce cooling energy load, improve building occupant comfort, and help reduce the heat island effect. Effective June 1, 2010, DOE required roof replacement activities and roofs on new facilities to be “Cool Roofs,” and in addition, have insulation installed of at least “R-30.”

2.1.5.1 Performance Status

In FY2004, Argonne began installing white and cool roofs and increasing the insulation levels. In FY2010, the insulation level requirement was increased to R-30. Between, FY2004 and FY2010, Argonne installed approximately 230,100 sq. ft. of cool roofs. This equated to about 10.9% of all the roof surfaces at the laboratory. In FY2011, an additional 4.0% of roof square footage was replaced with cool roofs. This included all of buildings 213, 370, and 223, and parts of buildings 362, 369, 211, and 221. In addition, two new facilities, buildings 371D and 528, were constructed with cool roofing. As part of other actions, two major buildings were demolished, buildings 310 and 330, which resulted in a reduction of traditional industrial flat roofing square footage, not meeting the insulation or cool roof requirements.

2.1.5.2 Planned Actions

Since FY2009, the roof replacement program has replaced about 53,000 sq. ft. per year or 2.0% annually. At the end of FY2011, approximately 14.9% of the total roofs at the laboratory are considered “cool roofs.” Over the next four years, pending funding availability, it is planned that the cool roof inventory will be increased at a rate of approximately 4% per year. By FY2015, the laboratory anticipates having over 25% of all roofs on-site considered “cool” or “green” roofs. The increase in cool roof inventory will include existing facility roof replacements and two new buildings presently under construction.

2.1.6 SF_6 Reduction

Sulfur hexafluoride (SF_6) is a nontoxic, nonflammable gas that is used in electrical systems (due to its high dielectric strength) to prevent arcing. Along with circuit breakers and switchgear in electrical transmission systems, SF_6 is employed at Argonne in such scientific applications as accelerators, Van de Graaff generators, and high voltage electron microscopes. Argonne also emits a small amount of GHGs from purchased refrigerants (see Figure 2-6).

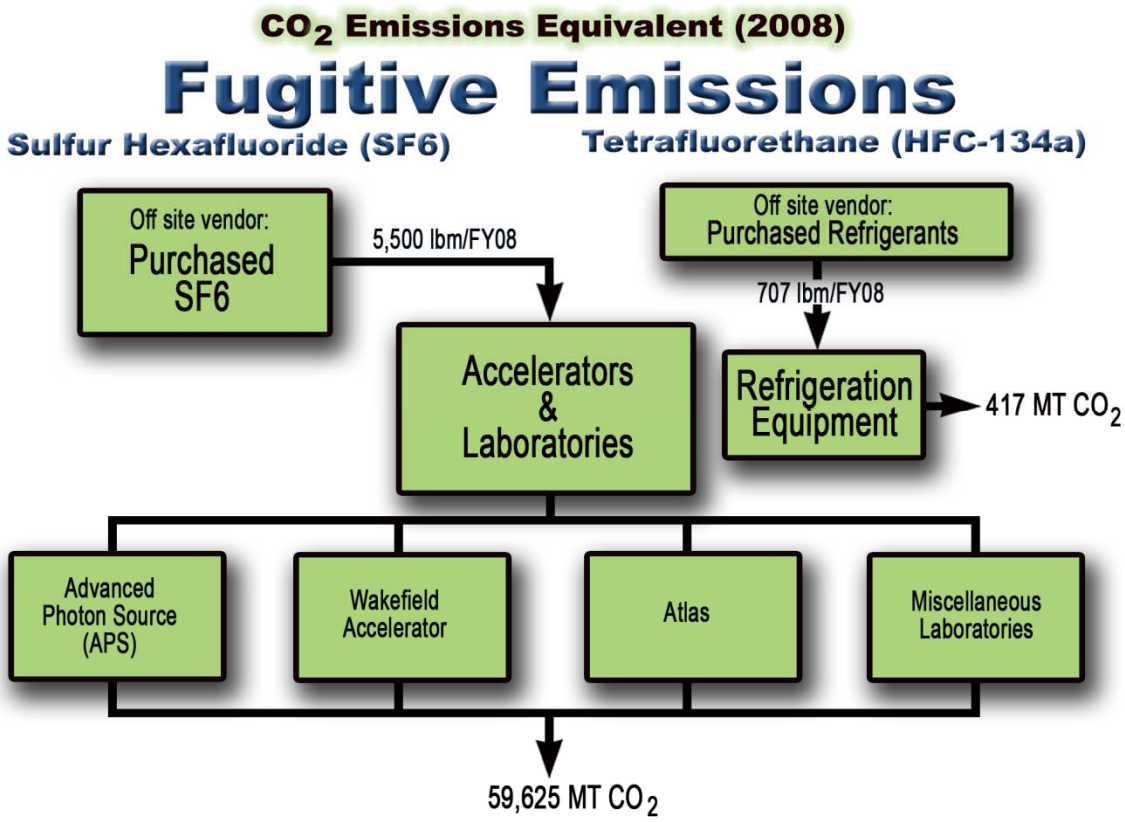


Figure 2-6: Fugitive Emissions

The global warming potential of SF_6 is significant, with one pound of SF_6 equivalent to 23,900 lb of carbon dioxide (CO_2). Emissions of SF_6 occur from two activities: losses through equipment leaks, and emissions when equipment needs to be opened for servicing and maintenance. While SF_6 is relatively inert, exposure to very high voltage environments can result in the creation of corrosive by products, which could require replacement of the gas. The SSPP commits DOE to acquire SF_6 capture and storage equipment, develop training, and deploy capture programs at key DOE sites.

2.1.6.1 Performance Status

In FY2011, efforts were continued by the SF_6 users group to minimize emissions through leak detection and repair, as well as to evaluate the needs for reclamation equipment. It was determined that the largest loss of SF_6 in FY2010 and 2011 was from the Argonne Wakefield Accelerator (AWA) of the High Energy Physics Division (HEP). Based upon the operation of this facility, and plans for facility expansion, a dedicated SF_6 recovery system was designed and installed (see Image 2-10). The reclamation system should reduce AWA emissions (692 lb in FY2011) by a significant amount. However, due to the time needed to integrate the operation of the reclamation system with accelerator operations (including some modifications to the accelerator), it may be some months before the effect of the SF_6 reclamation system is realized.

The APS originally had an SF_6 recovery system; however, its installation had never been completed, and a hardware/software upgrade was required to make the system operational. Funding was provided to APS, with a partial upgrade planned for the August/September 2012 shutdown. This upgrade will allow for debugging and eventual complete implementation of the reclamation system.

Image 2-10: AWA SF_6 Recovery System Control Panel

For smaller users of SF_6 (e.g., electron microscopes), a visit by the vendor to meet with users and tour their facilities resulted in a design of a portable system. Its effectiveness was still being evaluated at the end of FY2011.

A meeting was also held with the major SF_6 gas vendor to determine a path forward for reclaimed or contaminated SF_6 that would be removed from systems; however, because of purity concerns could not be reused. A program for recycling used SF_6 back to the vendor for eventual reclamation will be evaluated.

In addition, in order to more accurately determine SF_6 inventories and usages, two portable SF_6 cylinder scales were purchased for use around the site. Their use should help track the return of cylinder “heels” (residual material left in cylinders) so that they are not counted towards emissions.

2.1.6.2 Planned Actions

Planned actions include continued implementation of leak detection and repair procedures. Installation of the AWA reclamation system and upgrade of the system at APS are scheduled for FY2012. The implementation of a program to weigh SF_6 cylinders will continue as well as a decision to pursue acquisition of a portable SF_6 reclamation system for small scale users. With an improved leak detection, repair, and recovery program and equipment, Argonne hopes to achieves at least a 90% reduction in SF_6 emissions within one to two years.

2.1.7 Overall Reduction of Scope 1 and 2 GHG Emissions

The DOE goal for Scope 1 and Scope 2 Greenhouse Gas Emissions reductions is 28% by FY2020 (from the FY2008 baseline).

2.1.7.1 Performance Status

Table 2-4 shows Argonne’s official FY2008 Scope 1 and 2 GHG baseline and FY2011 emissions.

Table 2-4: 2008 Scope 1 and Scope 2 GHG Reduction Performance		
Input	**FY2008 – baseline (MT CO_2e)**	**FY2011* (MT CO_2e)**
Electricity	186,516	189,786
Coal	24,063	10,630
Natural gas	36,150	44,736
Gasoline	608	158
Diesel	366	241
E-85 (ethanol / gasoline)	46	53
F-Gases (SF_6, HFC-134A, PFC)	60,041	13,282
Fugitive landfill gas and wastewater treatment	2,275	1,741
Totals	310,065	260,627

* FY2011 data sources: Electricity, coal, natural gas, gasoline, diesel - CEDR 2012 Tab 3.2; E-85 – Fleet GHG Emission Calculation Tool.xls; F-Gases: CEDR 2012 Tabs 7.3 & 7.6; landfill gas and wastewater treatment: CEDR 2012 Tabs 7.4 & 7.5.

As shown in Table 2-4 and Figure 2-7, Argonne has achieved a 16% reduction in Scope 1 and 2 GHG emissions. This was achieved mainly through a dramatic reduction in SF_6 fugitive emissions. Emissions related to heating at steam production dropped nearly 10%; however, there was a slight bump in purchased power emissions due to start up of new facilities and laboratories. Overall, however, the large fugitive emissions reduction more than compensated for the purchased power increase.

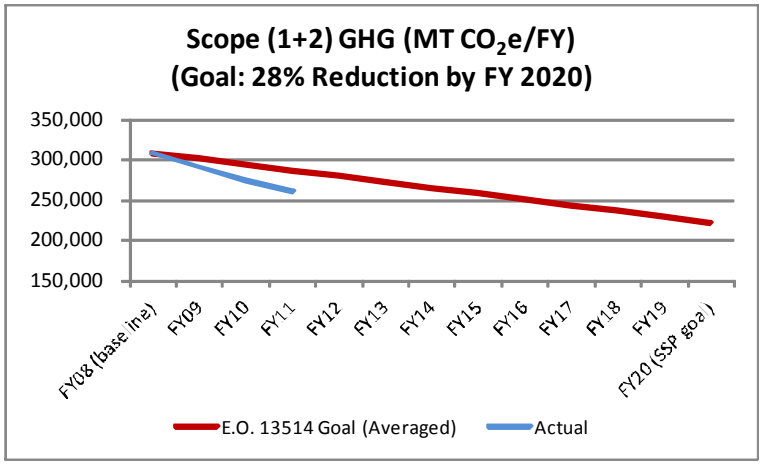


Figure 2-7: Scope 1 and Scope 2 SSP Goal

2.1.7.2 Planned Actions

As indicated in Section 1, Argonne has developed a multi-faceted action plan that includes Scope 1 and 2 components in electricity, fuel combustion, and fugitive emissions. With full implementation, Argonne expects to exceed the 28% DOE target for Scope 1 and 2 GHG emissions and achieve a 40% reduction. Table 2-5 shows Scope 1 and Scope 2 reduction targets.

Table 2-5: Scope 1 and 2 Reduction Targets			
Focus Area	Scope 1 FY08 Emissions (MT CO_2e)	SSP Reductions (MT CO_2e)	Reduction (percent)
Transportation (Scope 1)	1,011	195	19%
Steam Production	59,259	36,080	66%
Electric Intensity	186,516	42,000	23%
Fugitive Emissions (F-gases, Landfill, and Wastewater)	62,317	54,036	87%
Total	309,103	132,311	43%

2.1.8 Training

DOE Order 430.2B requires training for energy and water management personnel. The SSPP commits DOE to having a site energy manager at each site, with certified energy manager (CEM) qualifications, as well as the inclusion of energy conservation and recycling training in employee orientation programs.

2.1.8.1 Performance Status

Argonne has taken a number of steps to improve the knowledge and expertise of its core sustainability team. Training has included:

- "Lunch and Learn" seminars on energy and water savings technologies and products, including topics relating to:
  - AMEIS
  - Lab controls and energy saving fume hoods
  - Renewable energy
  - Tubular, reflective natural-lighting devices
  - LED interior lighting
  - Energy improvement products
  - Thermal imaging
  - Building automation and control networks
  - Refrigerant fluids
- FEMP webinars
- Participated in Sustainability Assistance Network (SAN) monthly conference calls
- Participation in major federal and local conferences such as GovEnergy, Greengov, ComEd Energy Efficiency, Labs 21 and Green Building
- Argonne has four CEMs and one LEED Accredited Professional (AP) architect on staff. These individuals maintain certification and meet all continuing education requirements.

To affect workforce awareness and engagement in sustainable behavior, Argonne has developed and implemented sustainability training courses for employees. These include:

- A P2 training course mandatory for all employees
- EMS and ISO 14001 courses that over 450 managers and environmental compliance representatives have completed

2.1.8.2 Planned Actions

Full employee and management commitment is necessary to achieve Argonne's sustainability goals and vision. Continuing training will continue to be offered to maintain sustainability and energy management and green building staff qualifications. "Lunch and Learn" seminars will continue to be offered and employees will be encouraged to attend sustainability and energy management webinars.

Additional sustainability program training sessions will continue to be developed, including the enhancement of employee awareness in topics such as:

- office energy and water management and conservation;
- energy dashboard utilization;
- sustainable employee commuting;
- integration of sustainability into work planning; and
- sustainable acquisition strategies.

2.1.9 Communications

DOE Order 436.1, Departmental Sustainability, requires employee incentive and outreach programs in order to motivate employees to become more efficient in their use of energy, water, and green products and services, and to minimize waste, reduce utility costs, and reduce greenhouse gas emissions.

2.1.9.1 Internal Communications

To affect workforce awareness and engagement in sustainable behavior, Argonne has implemented and maintains a wide variety of dynamic communication vehicles. These include:

- Annually published Energy/Sustainability Report
- Strategic Sustainability Communications Plan
- A multitude of articles and videos published in *Argonne Today*, *Focal Point*, *What's New at Argonne* and on Argonne's GreenLab Initiative website
- Sustainability trade-show exhibit with video monitor, where sustainability information is displayed, and informational and promotional items are available for take-away (see Image 2-11)
- Events, contests, and other engaging initiatives are held frequently
- Variety of posters and electronic posters
- Gate sign notification of sustainability events, contests, and new programs
- Portable, free-standing banners for use at events, trade shows, and conferences

Image 2-11: Solutions for a Sustainable World Exhibit

2.1.9.2 External Communications & Outreach

To affect awareness about Argonne's Sustainability Program throughout DOE, DOE complex facilities, and the public and the surrounding community, Argonne produces a variety of external communications and participates in a number of outreach programs. These include:

- Continuously updated GreenLab Initiative website
- Development of Argonne's Sustainability Workshop for middle school teachers (a college accredited course) (see Image 2-12).
- Brochure promoting Argonne's Summer 2012 Sustainability Workshop for middle school teachers, has been produced and is being distributed to middle schools throughout the surrounding community
- Argonne regularly hosts middle-school students from the surrounding community, including students from Chicago Public Schools, at the laboratory for leaning-based sustainability demonstrations on superconductivity and transportation, including hands-on elements such as a model car levitating across a racetrack and students riding an energy bike. The students compare incandescent, fluorescent and LED lighting, and how much effort it takes to produce the same amount of light.
- Community Leaders Round-Table Meeting — Members include elected officials on the village, city, township, county and state levels; persons appointed to lead school districts, environmental boards and other government agencies; and officers of labor unions and home owners associations.
- Argonne's Sustainability Team regularly presents papers and presentations at regional and national sustainability conferences and symposiums.

Image 2-12: Local Middle School Teachers Participate in Renewable Energy Exercise during a 2011 Sustainability Workshop

2.1.9.3 Planned Actions

Full employee and management commitment is necessary to achieve Argonne's sustainability goals and vision. An employee rideshare program and web application, GreenRide Connect, and several contests are scheduled to launch in 2012 to develop awareness and encourage involvement. A set of contests will be designed around green transportation through employee commuting and employee business travel. Another set of contests will host a competition between buildings on-site to reduce electrical energy consumption. Development of the EIS dashboard and display of power and sustainability data will also greatly enhance energy awareness. Argonne has also procured safe and affordable plug meters that will be given to employees to monitor their power consumption both at work and at home. Incorporation of this type of tool will increase impact and awareness of how employees can cut their power demand at work and save on their home electricity bills.

As detailed in Sections 3.0 and 4.0, the laboratory has also set up a Strategic Transformation Team to get researchers involved in identifying sustainability solutions. The GreenLab Initiative and Sustainability Idea Exchange websites include features that stimulate creative thinking and gather sustainability ideas from all employees.

Argonne's Sustainability Communications Plan also outlines training, posters, talks, and awards designed to educate employees and acquire their commitment.

2.2 Scope 3 Greenhouse Gas Emissions Reductions

The major sources for Scope 3 emissions are employee commuting, business ground and air travel, electrical transmission and distribution (T&D) losses, off-site wastewater treatment, and off-site waste disposal. DOE is committed to reducing its Scope 3 emissions 13% by FY2020. Table 2-6 presents Argonne's FY2008 Scope 3 inventory and FY2011 emissions figures.

Table 2-6: Scope 3 Inventory Baseline and Reductions			
Category	**FY08 Amount**	**FY08 MT CO_2e**	**FY11 MT CO_2e**
T&D Losses (MWh)	16,435	11,521	11,634
Business air travel (miles)	23,863,555	6,535	5,880
Business ground travel (miles)	1,365,743	512	578
Employee commute (miles)	≈34 million	11,386	11,587
Total		**29,954**	**29,679**

2.2.1 Performance Status

Table 2-7 and Figure 2-8 show that Argonne's Scope 3 emissions have slightly decreased (by 0.2%) since 2008. The T&D losses went up slightly due to new facilites coming on-line and a employee commuting miles increased due to an increase in the site occupant population. Business travel emissions decreased slightly due to changes in trip distances and also fewer trips as a result of cost-cutting measures in FY2011.

As part of the Argonne GreenLab Initiative, a Sustainable Employee Commuting Committee (SECC) was established to formalize the commuting strategy for the laboratory. The Sustainable Employee Commuting Strategy includes four components:

- Better access to and greater participation in the regional mass transit system;
- More comprehensive on-site campus transportation options (bike share, shuttles, etc.);
- Greater and more formally tracked telework participation; and
- Greater and more formally tracked ridesharing, by car or vanpooling.

In FY2011, the Sustainability Program procured and customized a ride-share matching software called GreenRide Connect. GreenRide Connect is an easy-to-use application that allows you to create a commute profile, find carpool matches in your neighborhood or along your route, and track your commuting and see actual money savings and environmental benefits.

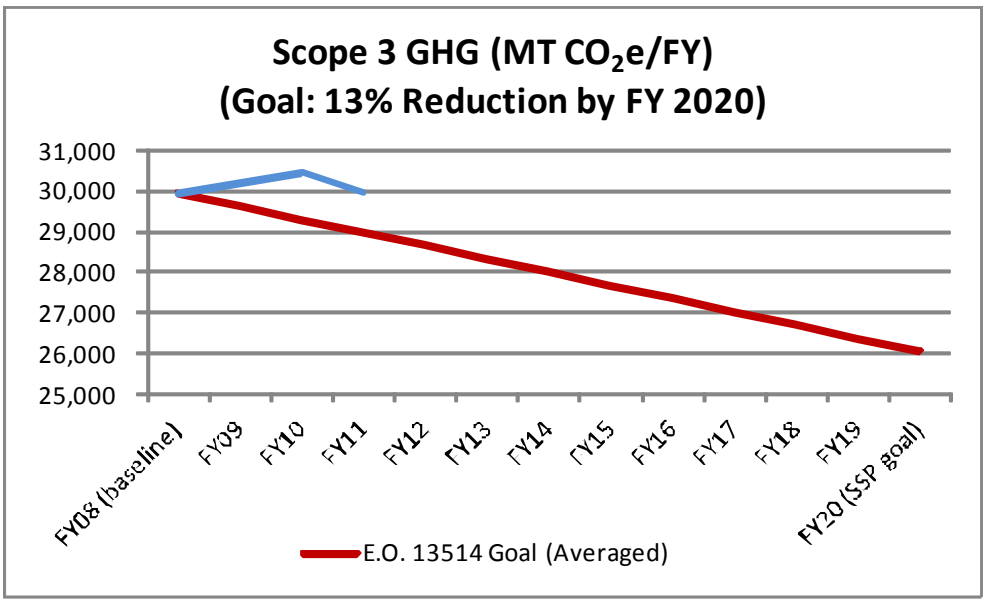


Figure 2-8: Scope 3 GHG Goal and Progress

Table 2-7: Major Strategic Initiative Summary: Scope 3 Emissions			
Focus Area	**FY2008 Emissions (MT CO_2e)**	**SSP Reductions (MT CO_2e)**	**Overall GHG Reduction (%)**
T&D losses*	11,251	4,482	40
Business air travel	6,535	654	10
Business ground travel	512	51	10
Employee commute	11,386	1,708	15
Total	**29,954**	**6,895**	**23**

*Site-specific T&D loss factors will be used in FY2013 and beyond, resulting in more accurate reporting.

2.2.2 Planned Actions

The three largest contributors to Scope 3 emissions are employee business air travel, employee commuting, and electrical T&D losses.

Argonne employees travel about 24 million air miles per year. Reduction efforts include:

- Evaluation of future air travel to determine the necessity of trips needed for mission accomplishment.
- Evaluation of alternative transportation modes (rail, bus) for short trips (<300 miles).
- Continued increasing use of web-based meetings and teleconferencing to replace business trips.

During early FY2012, the GreenRide Connect ride share matching software will be deployed and employee enrollment will be promoted and tracked throughout the remainder of the year. Three short-duration commuting contests are planned for the fiscal year to maintain a high level of participation and enthusiasm in sustainable commuting. The laboratory will also evaluate the benefits of establishing a pre-tax commuter spending program to encourage greater participation in mass transit and van pooling. The SECC will work with the Pace regional suburban bus service to encourage ridership and pursue convenience improvements such as bus shelter installation and preferred Metra vanpool commuter parking spaces.

Also, access to mass transit options will be better communicated to employees by documenting defined commuting corridors that service each Argonne employee commuting cluster. The SECC will work to establish better transportation from the Argonne gates to the employee's building, to encourage greater mass transit ridership. The SECC will work to better promote and track routine, documented employee telework and alternate work schedule participation. These efforts will be followed by a new commuting survey during late FY2012 to measure improvements and more accurately calculate GHG emissions resulting from commuting.

The preferred parking program will be expanded to provide incentives for use of car and vanpooling and hybrid and low-emission vehicles.

Due to plans to drop purchased power use in the short term through the CHP plant, reduced T&D losses will significantly help drive Scope 3 emission reductions. However, as power demand increases with construction of new HEMSFs, this number may begin increasing, so that additional offsets from the transportation area may be required.

DOE requires reporting of T&D losses based on default loss factors in CEDR, but Argonne's actual site-specific T&D losses were much lower than the default value. Therefore, when compiling data for future SSP updates, actual T&D loss factors will be utilized by rebaselining

and recalculating subsequent years to date. It is expected that this will result in much more accurate reporting and leverage the benefits of other Scope 3 GHG reduction strategies (employee commuting and business travel).

2.2.3 Behavior Change

This section provides a brief summary of behavior change methodologies discussed throughout Argonne's SSP. It is first necessary to educate employees and increase awareness of opportunities to decrease Argonne's emissions. This will be done through training, briefings, information kiosks/displays, our GreenLab Initiative webpage, the Sustainability Idea Exchange, and development of the energy and greenhouse gas information system. The information presented will describe the challenges faced, progress to date, and how all employees can positively contribute. Examples of how employees can help will be regularly provided (e.g., green purchasing reminders; recycling reminders, eliminating office refrigerators and microwaves, eliminating space heaters, turning off lights, lowering thermostats, shutting down computers, etc.).

Sustainable behavior and participation will be encouraged through competitions involving reduction strategies such as:

- Employee energy reductions using energy dashboard data electric meter data;
- Use of GreenRide Connect to increase and track car pooling, biking, high-efficiency vehicles, telework, and mass transit; and
- Reduction of employee business travel through expanded use of videoconferencing.

The contests may eventually expand beyond workplace "green" practices by crediting sustainable behaviors employed outside of work.

Argonne also plans to continue its participation in the American Cancer Society's annual Active for Life Program – a contest for healthy living that provides point rewards for walking, biking and other activities, and participation in "Bike-to-Work" week(s).

To also encourage and promote sustainability, the laboratory will continue awards programs to recognize grass-roots, innovative ideas and for excellence in practicing sustainability.

2.3 Comprehensive Greenhouse Gas Inventory

Table 2-8 gives a breakdown of Argonne's overall GHG baseline inventory and reduction targets.

Table 2-8: Major Strategic Initiative Summary

Focus Area	FY2008 Emissions (MT CO_2e)	SSP Reductions (MT CO_2e)	Overall GHG Target Reduction (%)
Transportation (Scopes 1 and 3)	19,445	3,000	15
Steam Production (Gas and Coal)	59,259	36,080	61
Electricity (Scopes 1 and 3)	186,516	42,000	23
Fugitive Emissions (F-Gases, Landfill, and Wastewater)	62,316	54,036	87
Total	**327,536**	**135,116**	**41**

The laboratory is outlining an aggressive GHG reduction program; however, Argonne's actual and planned growth since the 2008 GHG baseline makes the EO goals more challenging. Four major new facilities — the Theory and Computing Sciences (TCS) building, the Ricketts Laboratory, the Argonne Leadership Computing Facility (ALCF), and the SAMM facility — have come on-line since FY2008.

Adding to the growth are near-term startups of the new central chilled water plant, the ESB, and the APCF. The APS upgrade may also result in an incremental increase in electrical demand.

To balance this growth, Argonne is aggressively working to demolish legacy facilities that, although unused, still require some heat and power for safety and security reasons. Buildings 301, 310, and 330 (a total of 124,193 sq. ft.) were recently demolished. Argonne is also de-inventorying several nuclear facilities in preparation for deactivation and demolition. Critical to the success of Argonne's sustainability plan is the laboratory's ability to obtain continued support from the DOE Office of Environmental Management to decontaminate and decommission legacy facilities. In the interim, Argonne is evaluating how operations can be consolidated through footprint reduction, such that entire buildings and/or wings can be put in low-energy-use status. Although this would lower energy consumption considerably, the Chicago area climate requires heating of the building to prevent freezing of water-based fire protection systems.

Purchased electricity is the source of approximately 73% of Argonne's Scope 1 and 2 GHG emissions. The current Environmental Protection Agency (EPA) e-Grid emission factor for Argonne's region is 0.701 metric tons of CO_{2e}/MWh purchased. However, the local disclosure from Commonwealth Edison based on the actual utility plant makeup in their distribution region is 0.47 metric tons of CO_{2e}/MWh (for 12-month period ending on June 30, 2011). Unfortunately, current policy requires use of the e-Grid factors. Argonne will continue to explore methods of crediting purchase of clean power that is produced off-site, through mechanisms such as power purchase agreements. With predicted growth, especially in the area of HEMSFs, the accounting of GHG from local utilities will be critical for Argonne's and DOE's success in meeting GHG goals (more detail on HEMSFs is provided in Section 5.0).

2.4 High-Performance Sustainable Design

Argonne's goal is to certify 15% of its new and existing buildings (over 5,000 sq. ft.) as meeting or exceeding HPSB guiding principles or LEED criteria by 2015. LEED is a green building certification system developed by the U.S. Green Building Council that provides a green building design framework and certification via an independent, third-party verification that a building was built or retrofitted using high-performance or green features. The HPSB guiding principles comprise sustainability objectives and criteria developed by the federal Interagency Sustainability Working Group; achievement of these objectives is determined through self-validation. Existing buildings that meet the LEED criteria are considered as also meeting the HPSB principles.

Four buildings currently meet these criteria, and eight more HPSB-validated or LEED-certified buildings will be needed by FY2015, based on an expected growth of the Argonne campus to 76 buildings of 5,000 sq. ft. or more by FY2015. Table 1-3 shows the buildings that Argonne expects to meet the criteria and contribute toward the 15% goal.

2.4.1 HPSB New Construction

2.4.1.1 Performance Status

Preliminary design for the ESB (see Image 2-13) was completed in FY2010, and construction began in FY2011. The design LEED assessment indicated that the facility was designed to achieve LEED points exceeding LEED Gold status.

Construction on the 200 Area chilled water plant was completed in FY2011, and the LEED documentation is being compiled for submittal in FY2012.

2.4.1.2 Planned Actions

Argonne has several projects in the new construction/development phase that are being designed and built to meet EO requirements:

- ESB
- APCF
- CHP plant

Image 2-13: Energy Sciences Building, Currently under Construction

Integrated Sustainable Design of the ESB

Sustainable building practices are an integral component of environmental stewardship and when successfully applied, make a positive contribution to the environment globally, regionally, and locally.

FMS is leading the ESB's integrated design team, which includes DOE, building users, Argonne subject matter experts, and an architect. The design team's efforts started at the beginning of the project and will continue throughout the project's life, assuring good design and sustainable practices.

2.4.2 HPSB Existing Buildings

Argonne is using the EPA portfolio manager to assess existing buildings as candidates for system modifications that would benefit the environment. Facilities that have the greatest potential and economic feasibility will be included in the HPSB existing building program. Argonne anticipates that only two additional existing buildings will need to be retrofitted to meet the HPSB principles to contribute to the goal by 2015 if all new buildings are funded and completed as planned.

2.4.2.1 Performance Status

In FY2011, the building 438 LOM (see Images 2-14 and 2-15) was retrofitted for improved energy and water conservation. Argonne has validated that building 438 now meets the HPSB guiding principles, the first non-LEED-qualified Argonne building to do so.

Argonne has built and is operating the following existing LEED-certified buildings, which also qualify for HPSB status:

- Building 46 – Shipping & Receiving

- Building 216 – SAMM Facility
- Building 440 – CNM

In FY2010, Argonne evaluated all existing facilities to identify those with the greatest potential to meet HPSB guiding principles. This evaluation continues to provide the basis for future HPSB efforts. Argonne has also revised many internal policies and procedures to reflect the HPSB guiding principles. Twenty guiding principles were integrated in this way.

Image 2-14: Building 438 LOM, Retrofitted in FY2011

Image 2-15: Building 438 LED Lighting Upgrade

2.4.2.2 Planned Actions

The most promising candidates for HPSBs continue to be the LOMs at the APS. Eight LOMs are categorized as separate buildings in the Facilities Information Management System. They are nearly identical in construction, allowing for reproducible results and economies of scale. In addition to LOM 438, the laboratory has chosen to retrofit up to five additional LOMs that, if implemented for all five, would help Argonne exceed the 15% HPSB goal.

By the end of 2012, Argonne will finalize the project plans and budget request(s) for the remaining LOM upgrades to meet HPSB requirements. Argonne anticipates changes to the mechanical systems, water fixtures, building envelope, and electrical systems will be required (Figure 2-9).

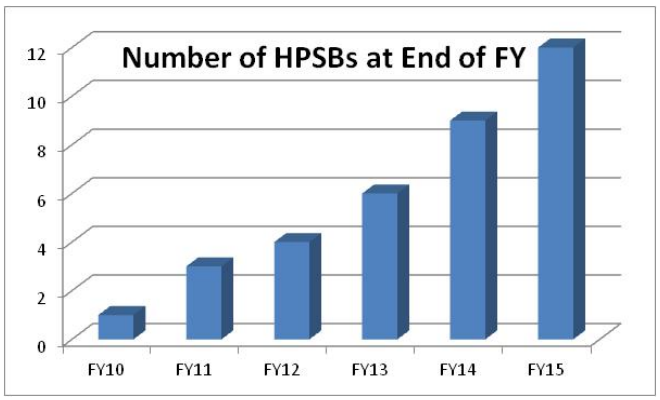


Figure 2-9: Growth of HPSB-Validated Buildings through FY2015

2.5 Regional and Local Planning

The SSPP and EO 13514 require DOE to participate in regional planning activities; align policies with local planning efforts; ensure that planning for new facilities considers interface with local developments; identify impacts of energy usage and alternative energy sources in National Environmental Policy Act documents; and coordinate with regional programs for ecosystem, watershed, and environmental management.

2.5.1 Performance Status

Argonne has established a number of community outreach programs to interface with the laboratory's neighbors and the public in general. The main communication vehicles are the Community Leaders Round Table, Community Update Newsletters, tours, and the Argonne Speakers Bureau. In addition to these, Argonne maintains a public website (Image 2-16) that provides information on many topics, including the GreenLab Initiative and sustainability program information. The GreenLab Initiative website is routinely updated with new information to communicate Argonne's sustainability successes to the community.

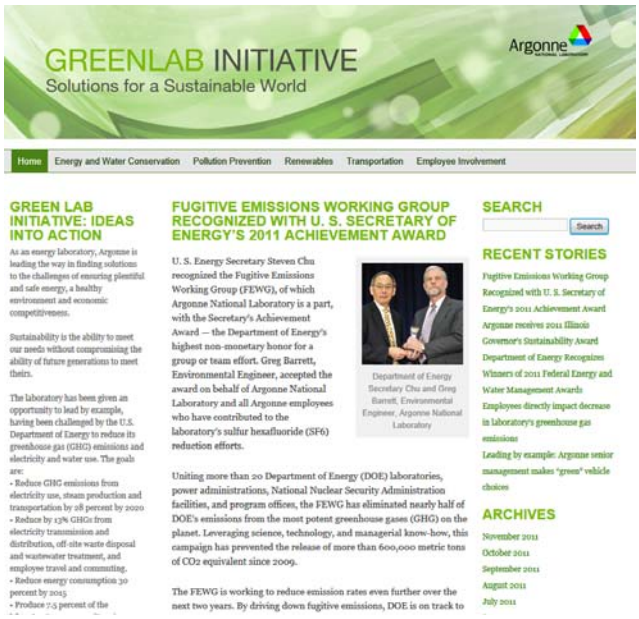


Image 2-16: GreenLab Initiative Web Site

2.5.2 Planned Actions

Argonne plans to use the established communication vehicles to address cooperative efforts related to regional and local planning. The Community Leaders Round Table, which is composed of elected and appointed public officials, will be the primary bridge between Argonne and the public and local officials in addressing the requirements of the SSPP and EO 13514. Specific regional and local individuals and organizations will be identified, and cooperative relationships will be developed. Argonne long-range site development processes will play a leading role in generating information for this interface.

Argonne's GreenLab Initiative website will continue to be updated and improved as the sustainability program continues to mature.

2.6 Water Use Efficiency and Management

2.6.1 Water Efficiency

Water used at Argonne originates from two sources: (1) potable water for domestic and laboratory use is supplied by the DuPage Water Commission, and (2) industrial water for building and process cooling is drawn from the nearby canal. Each of these uses is discussed more fully below. The EO 13514 sustainability goals are:

- Potable Water: Reduce the potable water intensity (gal/GSF) ratio by 16% by the end of FY2016, relative to FY2007. EO 13514 extended that goal to reduce potable water use by 26% by FY2020. Argonne has already met the FY2016 goal.
- Industrial Water: Reduce industrial, landscaping, and agricultural (ILA) water consumption by 20% by FY2020, relative to FY2010. Most ILA water at Argonne is used as cooling tower makeup water.

2.6.1.1 Performance Status

Potable Water: As shown in Figure 2-10, by the end of FY2010 Argonne had exceeded the water intensity reduction goal, exceeding the FY2016 goal (16% total reduction) in only four years. By the end of FY2011, Argonne had reduced potable water consumption by 23.5%, nearly meeting the FY2020 goal (26% total reduction). A number of water conservation measures were completed or initiated in FY2011. The most significant reductions were made by recirculating the cooling water from air conditioner units to the central chilled water loop, instead of once-through usage. The resulting water savings of 29 million gal/yr equated to a cost savings of $74,576 during FY2011. Figure 2-11 shows the potable water intensity reduction strategy including the strategy to reduce water intensity beyond the goal by FY2020 (55% reduction possible based on current plans).

ILA Water: During FY2011, Argonne reduced industrial water usage by about 4.5 million gallons from the previous year, a 2.4% reduction. At this pace, Argonne will exceed the 20% total reduction required by FY2020. Argonne's landscaping practices continue to employ water-use reduction practices, including matching planting schedules to seasonal precipitation patterns so new plants have time to become established without intensive watering and selecting drought-tolerant plants. Native Chicago area plants, such as prairie dropseed and bur oak, reduce landscape water demands. Plants that require more watering are minimized or integrated into settings with naturally occurring water.

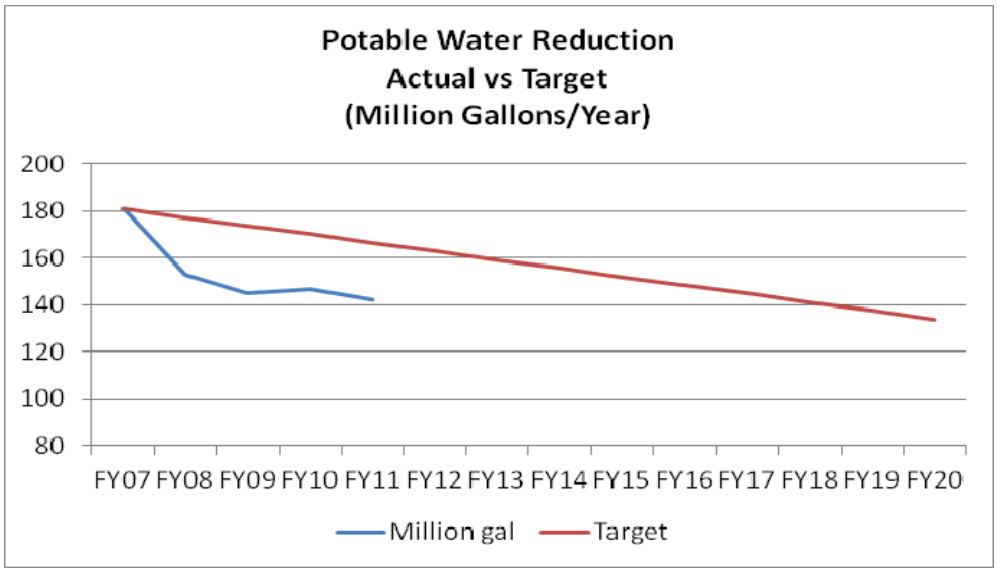


Figure 2-10: Potable Water Consumption with Respect to Reduction Goals

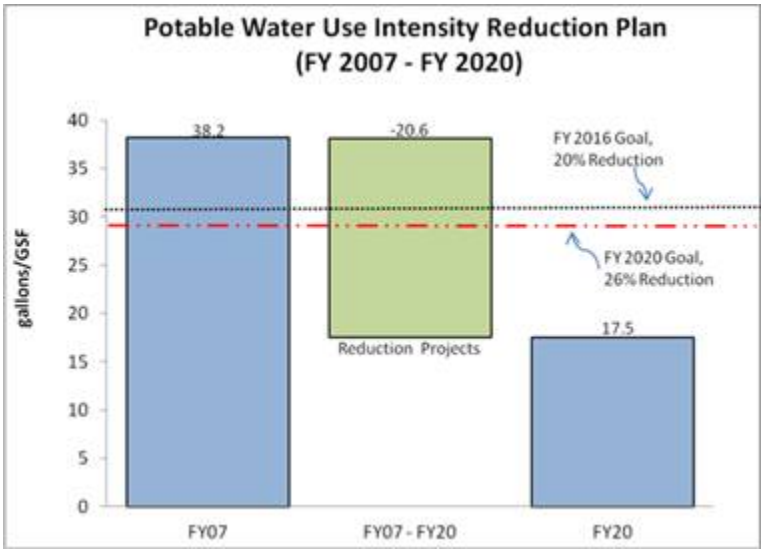


Figure 2-11: Potable Water Use Intensity Reduction Plan

2.6.1.2 Planned Actions

Potable Water: Argonne's main potable water strategy is to repair condensate and steam traps and expand our water recycling program. Retrofit to low-flow fixtures will also be accomplished on renovations and new construction. Argonne expects that recycling alone will achieve the FY2020 26% reduction goal for potable water.

Water Conservation Measures

- Building 200 air compressors
- Building 202 and 203 air conditioner cooling water
- Cooling water recycling (site-wide)

ILA Water: The laboratory's main opportunity for ILA water reduction is in the area of cooling tower blowdown. By adjusting chemical treatment, it may be possible to reduce blowdown cycles at the larger cooling towers by over 50%. The other significant ILA water reduction opportunity is at Argonne's Central Steam Plant, which will be evaluated in FY2012.

Other potential measures for both potable and ILA water conservation include installation of an advanced metering infrastructure and reduction of leaks in the water distribution systems.

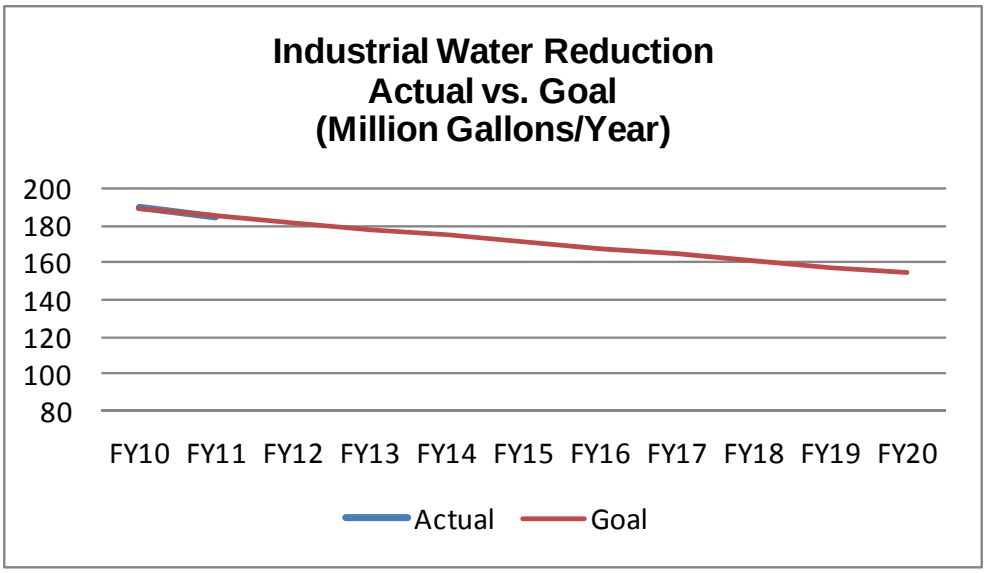


Figure 2-12: ILA Water Consumption with Respect to Reduction Goals

2.6.2 Stormwater Management

2.6.2.1 Performance Status

EO 13514 requires federal agencies to implement "green infrastructure" to reduce stormwater runoff from federal development and redevelopment projects. At Argonne, sustainable stormwater management ("green infrastructure") is integrated into new building designs, as well as in natural resource management activities across the Argonne site. The EO has provided technical guidance in conjunction with the EPA to assist facilities in complying with the new requirements. At Argonne, sustainable stormwater management activities are consistent with these guidelines, contained in the document *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act* (EPA Report 841-B-09-001, Dec. 2009).

Prior to FY2010 and the promulgation of EO 13514, Argonne voluntarily incorporated sustainable stormwater management into a variety of projects across the Argonne site, ranging from rain garden construction to wetland restoration efforts and establishment of native

vegetation as part of the rehabilitation of vacant parcels at the site. Table 2-9 summarizes these efforts.

Table 2-9: Stormwater Management Practices

Project Name	Fiscal Year	Description
CNM	2005	Rain garden construction and establishment of native plants to enhance soil quality and stormwater retention capability
East Area – Buildings 4, 5, and 6 demolition	2006	Establish native plants in former building footprints to enhance soil quality and stormwater infiltration capability
Building 46 expansion	2006	Establish native vegetation; first LEED project at Argonne (Silver certification)
SAMM Facility	2007	Stormwater retention basin constructed with improved native vegetation to promote stormwater infiltration; second LEED project at Argonne (Gold certification)
Wetland restoration east of building 240	2008	Wetland reconfigured to increase amount of stormwater retention in wetland to promote infiltration instead of runoff
Building 301 demolition and site restoration	2009	Former building footprint planted with native plants instead of grass to improve soil quality and enhance stormwater infiltration

Green Buildings: Projects initiated in FY2011 included the ESB and APCF. The LEED-inspired stormwater design elements of these buildings include directing roof, building footing, parking lot, and sidewalk runoff toward rain gardens and bioswale systems, which promote infiltration and transpiration of collected runoff instead of discharge off-site as stormwater. A planned vegetated stormwater infiltration basin at the ESB facility is intended to receive overflow from the rain garden/bioswale system in extreme rain events, promoting infiltration using an elevated overflow structure which directs only marginal volumes of water to the site stormwater drainage system. At the APCF building, the bioswale system is designed to retain and infiltrate the majority of runoff generated. Also being evaluated is the use of water-permeable pavers in the building parking lot instead of asphalt pavement.

Natural Resource Management: Argonne manages natural resources across the site, with activities focused on reducing the impact of road salt on site waterways (including Sawmill Creek), as well as restoring vacant portions of the site to native prairie conditions. In 2011, Argonne planted deep-rooted prairie grass in an effort to replace shallow-rooted orchard grass in two separate East Area locations, totaling about 3 acres. The deep roots of the prairie grass will promote deeper infiltration of stormwater into the subsurface, minimizing the amount of runoff into site waterways. In one area, restoration of native prairie took place between a roadway and Sawmill Creek and is expected to reduce the amount of salt-laden runoff entering the waterway.

2.6.2.2 Planned Actions

Green Buildings: At Argonne, sustainable infrastructure methods will continue to be incorporated into new building design and will be employed, when possible, in retrofitting existing buildings. Green infrastructure methods include establishment of rain gardens, bioswales, and conveyance features that promote downward infiltration and evapotranspiration of stormwater, rather than merely transporting stormwater to off-site waterways. Other green infrastructure stormwater management methods include use of permeable pavement for traffic areas and dispersal of roof runoff to open areas or engineered storm water infiltration features. These installations will be designed so that their performance will be measurable and continuously improved.

Natural Resource Management: In FY2012, Argonne will integrate stormwater control into natural resource management as follows:

1. Construct a rain garden as a key component of stormwater control at the 800 Area Soil Stockpile. This will channel the stormwater runoff to a permitted outfall further downstream.

2. Identify potential rain garden and bioswale candidates during routine site work activities. Areas of persistent standing water or localized flooding across the site will be documented, and the efficacy of constructing stormwater infiltration/transpiration features will be evaluated.

3. Continue site-wide prairie-restoration activities and plant deep-rooted native prairie plants on 3 acres of vacant land on the site. These activities improve water infiltration and reduce stormwater runoff in vacant areas.

2.7 Pollution Prevention (P2)

As part of Argonne's Sustainability Program, Argonne has established the following goals, consistent with DOE P2 Goals:

- Conduct PPOAs to increase source reduction of pollutants and waste and conserve energy and water;
- Divert at least 50% of nonhazardous solid waste by FY2015;
- Divert at least 50% of C&D debris by FY2015;
- Reduce use of printing paper;
- Increase use of uncoated printing and writing paper containing at least 30% postconsumer fiber;
- Reduce and minimize the acquisition, use, and disposal of hazardous chemicals and materials;
- Evaluate the diversion of compostable and organic materials from the waste stream;
- Implement integrated pest management and landscape management practices to reduce and eliminate the use of toxic and hazardous chemicals and materials; and
- Decrease use of chemicals to assist in achieving FY2020 GHG reduction targets (see Sections 2.1 and 2.2) (see Image 2-17).

Image 2-17: Pollution Prevention Campaign Poster

2.7.1 Performance Status

Argonne has had great success in conducting PPOAs; see Table 2-10 for the status of P2 efforts.

2.7.2 Planned Actions

Argonne will continue to nominate projects for DOE's Environmental Sustainability (E-Star) award programs to recognize and reward teams and individual programs that successfully reduce the generation of pollutants and wastes and effectively divert from disposal those materials that can be recycled or reused. Table 2-10 includes details on planned actions.

Table 2-10: P2 Goals, Status, and Activities

Goals	Performance Status	Planned Actions
Increase source reduction of pollutants and waste	Exceeded performance targets each of the last 5 years.	Continue to conduct PPOAs to identify opportunities for operational process, product, or behavioral changes. Four PPOAs are planned in FY2012.
Divert nonhazardous solid waste and nonhazardous, nonradioactive C&D debris	• Argonne has recycling contracts in place for many waste streams (i.e., electronics, scrap metals, plastic, glass, engine oil and antifreeze, construction demolition debris, and mixed office paper). • Argonne generated 1,033 metric tons of solid waste for off-site disposal and 1,177 metric tons of material that was recycled (53% diversion rate). • Argonne generated 3,778 metric tons of C&D debris for off-site disposal and 2,500 metric tons of C&D debris that was diverted from a landfill (40% diversion rate). • Argonne implemented a plan for increasing the placement of blue bag receptacles around the site (i.e., conference rooms and common areas). During FY2011, 250 receptacles were placed for the recycling of bottles, cans, glass, and aseptic containers. • Environment, Safety and Quality Assurance Division (ESQ) and FMS developed a plan to implement composting activities on site. • ESQ met with Procurement and FMS to develop contract language to meet goals. • Met with solid waste disposal facility contract representative to discuss: – Options for tracking solid waste and C&D debris waste streams and – Options for diverting C&D debris.	Activities underway: • Measuring sanitary waste and recycling volumes. Activities planned: • Evaluate opportunities to track projects that generate C&D debris. • Establish a pilot project for conducting zero-waste events (e.g., conferences, workshops, or social gatherings like staff picnics) to improve awareness and reduce landfill waste. • Meet with FMS project managers to assess the best format for reporting of C&D debris recycling activities from contractors. • Develop recommendations for the location of a compost facility on site.
Develop sustainable P2 practices to reduce use of toxic, hazardous, and GHG-emissions contributing chemicals	Actions to improve chemical management activities have been underway for years (i.e., accurate inventory management and the ability to identify and redistribute excess chemicals.	Activities underway: • Chemical Management System (CMS) facilitates re-use of chemicals available for use elsewhere in the laboratory. Activities planned: • Evaluate EPCRA reports, CMS and ozone depleting substances (ODS) and GHG inventories to identify chemicals of concern and potential P2 opportunities

2.8 Sustainable Acquisition

The SSPP commits Argonne to the following sustainable acquisition (SA) goals:

- Ensure that 95% of new contract actions, including task and delivery orders under new contracts and existing contracts, require the supply and use of products and services that are energy efficient (E-Star or FEMP-designated), water efficient, bio-based, environmentally preferable, non-ozone-depleting, recycled-content-containing, or non-toxic or less toxic.
- Update affirmative procurement plans (also known as green purchasing plans or environmentally preferable purchasing plans), policies, and programs to ensure that all federally mandated products and services are included in all relevant acquisitions.

2.8.1 Performance Status

The SA program continues to be strengthened to meet Argonne's commitment to EO 13514, which streamlines a number of new and previous directives into one comprehensive list of SA requirements. This section captures the SA requirements and resources for employees to specify SA products and services in Argonne contracts and establishes how preference is shown to SA items, when meeting the requirements of the purchaser. Also, Argonne captures SA statistics to allow for annual reporting and validation of SA implementation.

The laboratory's standard terms and conditions include SA requirements for the purchase recycled-content and janitorial products, office paper, plastic trash bags, toner cartridges, retread tires, and re-refined lubricating oils. The purchase of these and other recycled-content products have become commonplace at the laboratory, without a reduction in product quality. The governance of purchasing energy efficient products and the implementation of energy conservation practices outlined herein constitute Argonne's energy management program. Argonne will continue to procure and track purchases of the following products:

- Recycled content products, as described at http://epa.gov/cpg.
- Biobased products, as described at http://www.biopreferred.gov/.
- Energy efficient products, as described at http://energystar.gov/products for Energy Star products.
- Energy efficient products as described at http://www.femp.energy.gov/procurement for FEMP designated products.
- Environmentally preferable and energy efficient electronics, including desktop computers, laptops and monitors as described at http://www.epeat.net the Electronic Products Environmental Assessment Tool (EPEAT), the Green Electronics Council site.
- Green house gas emission inventories are required, including Scope 3 emissions that include contractor emissions as described in EO 13514.
- Non-ozone depleting alternative products, as described at http://www.epa.gov/ozone/strathome.html.
- Water efficient plumbing products, as described at http://epa.gov/watersense.

The exceptions to purchasing SA items are:

a) The item is not life cycle cost effective or exceeds 110% of the price of the non-sustainable item.
b) The item will not meet reasonable performance standards.
c) The item is unavailable in time to meet a critical need.

2.8.2 Planned Actions

Planned actions are to enhance the current Affirmative Procurement Policy by including the SA requirements contained herein. Also, the purchase of the applicable SA goods and services will be screened by sustainability subject matter experts during the procurement approval process to ensure that items are purchased in accordance with SA requirements.

2.9 Electronic Stewardship and Data Centers

Efforts and goals to meet sound principles for the electronic stewardship and management of data centers are given in Table 2-11.

Table 2-11: Electronic Stewardship and Data Center Activities

Goal	Performance Status	Planned Actions
1. Desktop Computer Energy Consumption: Reduce the energy consumed by desktop computing resources by 50%.	Deployed the Verdiem desktop power management product to all mission support computers and developed policies and schedules to balance sustainability goals and mission requirements. Approximately 1,100 computers are currently under active energy management, resulting in savings of over 78 MWh and 122,135 ton of CO_{2e}. Image 2-18 shows year-to-date summary information for this program.	Efforts are underway to test and deploy energy management throughout the scientific divisions, which is inherently more complex because of the close coupling to research activities. Energy management software will be deployed on more desktop systems throughout the laboratory with the goal of managing greater than 50% of desktops by the end of FY2012.
2. Data Center Energy Consumption: Reduce the energy consumed by enterprise and programmatic computing and data storage services by 10% per year through FY2014 (total reduction of 40% relative to FY2010). Enable programmatic divisions to deploy servers in centrally managed, high-efficiency data center space.	Virtualized approximately 50% of servers resident in laboratory enterprise data centers. Progress in data center energy reduction can be attributed mainly to virtualization, consolidation, and software as a service (SaaS) adoption. At this time however, it's difficult for the laboratory to accurately quantify the reductions since inventory, measurement, and metering capabilities are still being developed.	Approximately $2 million has been committed in FY2012 to execute the next phase of the sustainable information technology program, which will upgrade consolidation points and start moving equipment and services from inefficient legacy computer rooms into much more efficient facilities.

Table 2-11: (Cont.)		
Goal	**Performance Status**	**Planned Actions**
3. Data Center Energy Practices: Develop laboratory-wide requirements and guidelines for data center energy management and implementation of best management practices to drive: a) Centralization of new server deployments in high-efficiency on-site central data centers (implemented as "collocation space") and b) Where feasible, use of commercial cloud services rather than locally operated servers.	• Continued to transform the internal service model by adding 13 cloud-based services to the portfolio, providing better energy efficiency due to scale as well as flexibility. • Migrated a significant amount of services and equipment (65 total) from legacy data centers to modern, efficient space in the building 240 data center. • Assembled an interdisciplinary team to formulate a site data center road map. The first phase of this plan was completed with the delivery of a comprehensive data center assessment and consolidation recommendations and the creation and staffing of a full-time Data Center Manager position. The study identified 14 small data centers and computer rooms that would make excellent candidates for consolidation and energy savings.	As cloud and commercial services continue to mature, more consolidation will be evaluated and planned. The data center rehabilitation activities will make consolidation into efficient and stable environments possible.
4. Data Center Metering: By FY2012, install dedicated meters for all laboratory data centers not being considered for consolidation, to monitor or report energy efficiency metrics.	• Most data centers are not individually metered. New data centers are partially metered but not to the degree necessary to calculate and track efficiency using standard industry measures such as power usage effectiveness. • Full branch circuit monitoring capabilities were added to the building 240 data center, but work still remains before accurate facility performance can be assessed. Other data centers of interest have inadequate metering, and adding monitoring capability without impacting operations has proven challenging.	Additional metering will be implemented upon development of an overall consolidation strategy with the goal that all data centers (excluding those scheduled to be phased out by FY2014) will have dedicated electrical metering by the end of FY2012.
5. Ensure implementation of laboratory policies for environmentally sound practices for disposition of all excess or surplus electronic products.	The current laboratory policy was evaluated in FY2011, and compliance gaps were found.	The laboratory excess /surplus electronic disposition policy and process will be improved during FY2012.
6. Establish and implement policy to ensure use of power management, duplex printing, and other energy-efficient options and features on all eligible electronic products.	Updated all shared copiers and printers to default to double-sided printing and copying.	While all shared copiers have been set to default to double-sided printing, additional reductions will be evaluated through the elimination of unnecessary printers and consolidation of shared printers.

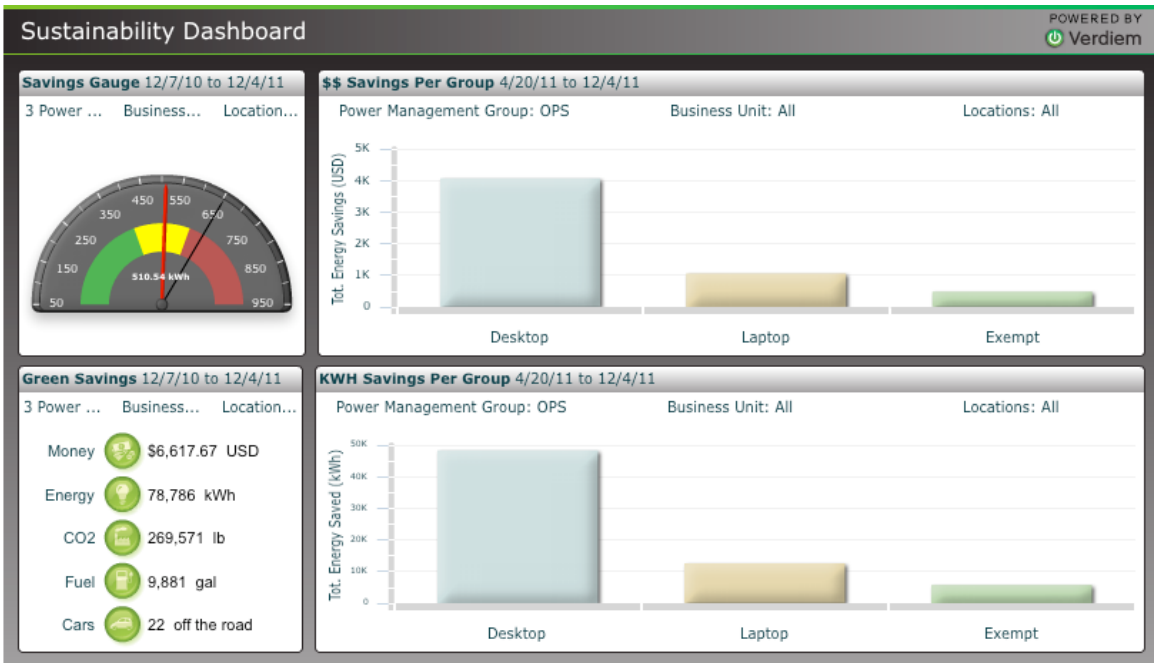


Image 2-18: Desktop Computing Energy Management Summary

3.0 Site Innovation

Argonne has long been an innovator in clean energy technology and climate change evaluation. Research divisions throughout Argonne are currently working in many areas of sustainability, including energy storage, resource efficiency, electric transportation systems, alternative fuels, and solar energy. In August 2010, Argonne established a sustainability site innovation team led by two of Argonne's leading programmatic researchers. The team's main mission is to engage our scientists and engineers and encourage the development of ideas for deploying sustainability technology at Argonne.

The team identified over 40 potential efforts that would help Argonne and DOE meet sustainability goals. The concepts considered span operations and behavior; sensing, assessment, analysis, and control; pilot-scale testing; and full-scale deployment. The team has evaluated the most promising ideas and continues to pursue these efforts.

Our intent is to work with and share ideas with other organizations – national laboratories, government agencies, universities, and industry – to expand the benefits of sustainability innovation to the Argonne site and elsewhere. Where appropriate, Argonne would license new technologies to firms for deployment through their customers.

Projects that continue to be pursued include the following:

1. Advanced Sensors and Control Systems for Site-Wide Real-Time Resource Management
2. Geothermal Systems with Heat Recovery Applications
3. Risk-Conscious Decision Analysis for Energy Retrofits (see sidebar)
4. Midwest Photovoltaics Analysis
5. Fuel Cell Applications with Waste Heat Recovery, Thermal Storage, and Renewable Fuels

Risk-Conscious Decision Analysis for Energy Retrofits

Retrofitting existing buildings to higher performance is one of the best ways to save CO_2 and energy use in the built environment. Realizing retrofits at large scale, however, will depend on a confluence of decisions, including those by public agencies in planning policy and incentives, utilities in executing energy efficiency (EE) programs, financiers in providing capital to the market, and building owners in deciding to invest in EE implementations. To effectively inform these retrofit decisions, a methodology is needed that scales to communities, captures energy performance of individual buildings, and correctly evaluates retrofit options in real contexts.

Argonne is developing a scalable methodology that supports energy retrofit decision-making at the individual and aggregate building levels. The risk-conscious decision tool under development, EEInvest, will provide advanced capabilities, including:

- Bayesian calibrated normative energy calculation methods for generating probability distributions of the expected energy savings from energy efficiency measures
- Financial risk analysis incorporating uncertainties in energy savings, energy pricing, and capital costs of energy efficiency measures
- Comprehensive methods for valuating energy efficiency

Normative energy models are derived from energy performance calculations that build from the vast amount of work and progress that the European Union (EU) has made in advancing building energy performance benchmarking.

To support the development and validation of the EEInvest tool, researchers will apply the normative energy calculations to evaluate energy efficiency measures in select Argonne office buildings.

At this time, Argonne is evaluating which projects to continue and fund in FY2012 using feasibility assessments and ROI calculations.

4.0 Management and Funding

4.1 Management

Figure 4-1 shows Argonne's sustainability program team organization chart. Dr. Paul Kearns, Deputy Laboratory Director for Operations, is directing Argonne's Sustainability Program Office. Dr. Mark Peters, Chief Research Officer and Deputy Laboratory Director for Programs, has been appointed as Sustainability Innovation Officer. Michael Dunn, FMS Deputy Director, provides program oversight (see Image 4-1). Devin Hodge is the Sustainability Program Manager. During FY2011, the sustainability, energy management, and environmental compliance functions were all reorganized into a new program office, FMS-Sustainability and Compliance (FMS-SEC) Program, to more organically integrate sustainability into Argonne's day-to-day operations and research activities. Sub-teams have been created to align with the major program focus areas and are led by senior managers and scientists. Supporting the sustainability program is Argonne's Sustainability Core Team (Image 4-2) and Energy Team (Figure 4-2).

4.2 Sustainability Funding in Overhead

Table 4-1 summarizes actual and planned expenditures for sustainability efforts.

Table 4-1: Actual and Planned Overhead Expenses				
Summary of Overhead Funded Projects ($K)				
Category	FY11 Actual	FY12 Planned	FY13 Projected	FY14 Projected
Water	70	50	50	50
Energy Efficiency (non-data center)	554	500	500	500
Energy Efficiency (data center)	127	2,000	TBD	TBD
HPSB	643	500	750	500
Metering	750	750	250	250
Cool Roofs	1,400	1,500	3,000	3,000
Behavior Change	273	125	125	125
Lighting	795	500	500	500
Renewable Energy	323	765	500	500
All other	225	250	250	250
Total	**5,160**	**6,940**	**5,925**	**5,675**

4.3 ESPC/UESC On-going and Planned

Currently, Argonne has three ESPC delivery orders in the performance stage, as summarized in Table 2-1. A new ESPC is in development for construction of a CHP plant. Project planning is underway and all parties continue to make progress toward an award during FY2012. Construction on the plant would not likely commence until FY2013.

4.4 Funding Sources and Return on Investment

This SSP includes continued use of energy savings contract (ESPC and/or UESC) financing for two major efforts; the CHP plant and a site-wide energy savings contract. Other sources of funding include Institutional General Plant Projects (IGPP) and Major Repair (MR) funding.

Argonne's energy savings reinvestment program is another source of funding. In a little over 2 years the program already generates over $500k in savings for investment in sustainability and energy and water conservation projects. The laboratory uses ROI as the main criterion for selecting projects under this program. The FY2012 budget also includes funding for the following initiatives:

- Sustainability communications and outreach;
- Renewable energy (wind, solar, geothermal) installations;
- Advanced metering and EIS deployment;
- HPSB evaluation and retrofits;
- Data center evaluation and consolidation;
- GHG reduction measures; and
- Sustainability program and project support.

To assist funding sustainability initiatives, Argonne continues to develop an EIS built upon advanced metering and collection of real-time energy data to provide critical information that can be used to drive positive behavior changes, load shedding, and/or load shifting. Load shedding can be used to reduce demand charges that typically make up 10% to 20% of a customer's power bill. Load shifting involves running equipment with high power consumption (e.g., chillers, high-performance computing routines) during off-peak hours to take advantage of rates that are 50-70% less than peak daytime rates. Argonne has already taken steps to improve capabilities in this area. Some advanced metering has been installed, and the CIS division continues to develop the EIS. The laboratory's full-time energy analysis team continues to evaluate energy use data and provide guidance to key personnel, such as plant operators, building engineers, and building managers.

Argonne also participates in a load-shedding program with utility providers. As part of this program, Argonne periodically sheds load and switches demand to standby generators to demonstrate grid relief capabilities. In FY2011, the success of those efforts brought $126,518 in rebates to the laboratory.

Image 4-1: Sustainability Management Team, right to left (M. Dunn, FMS Deputy Director; P. Kearns, Deputy Laboratory Director for Operations; E. Isaacs, Argonne Laboratory Director; and M. Peters, Deputy Laboratory Director for Programs; with J. Livengood, DOE-ASO Site Manager

Image 4-2: Sustainability Core Team

Facilities Management & Services Division
ENERGY PROGRAM OFFICE

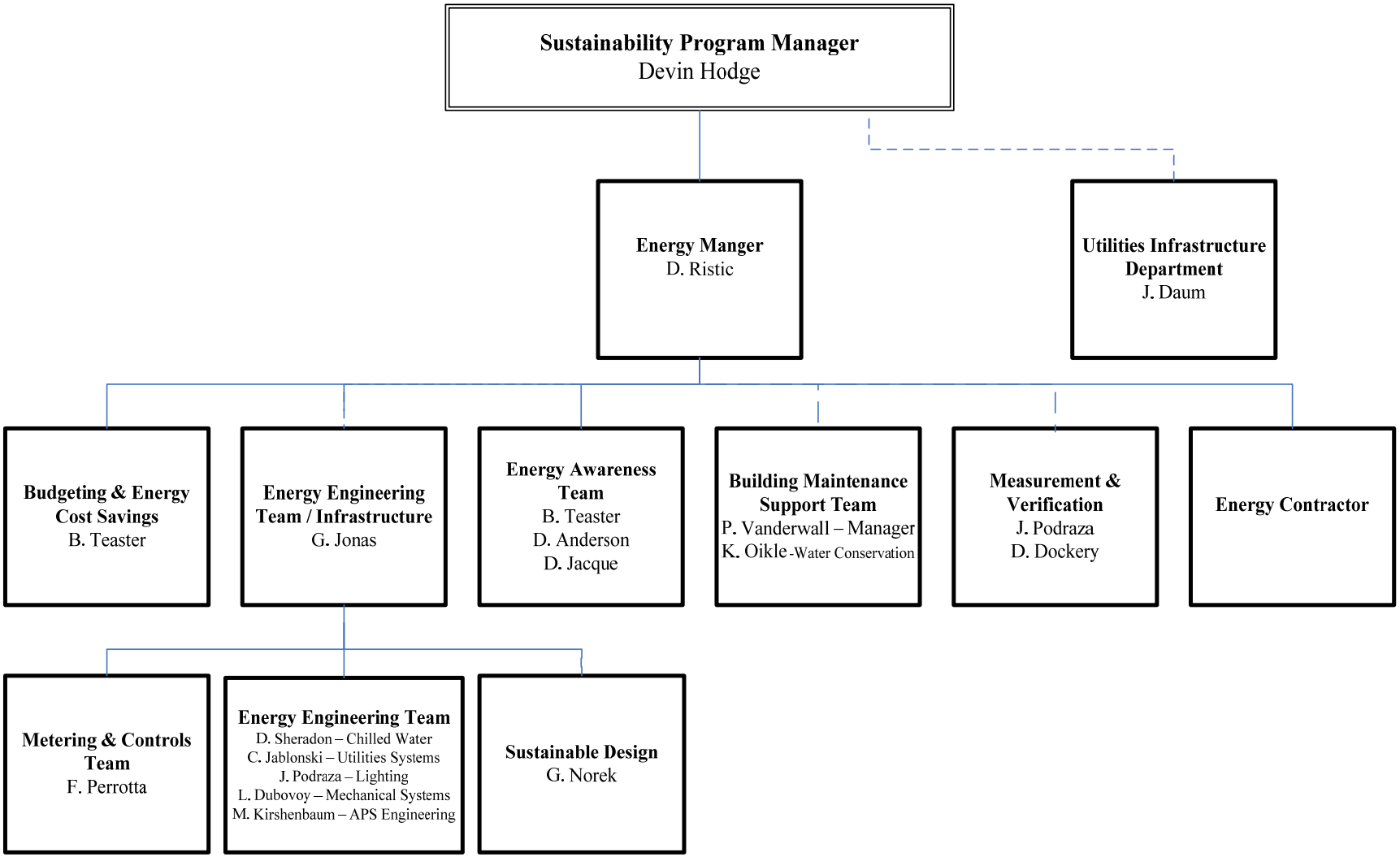


Figure 4-1: Energy Program Organization Chart

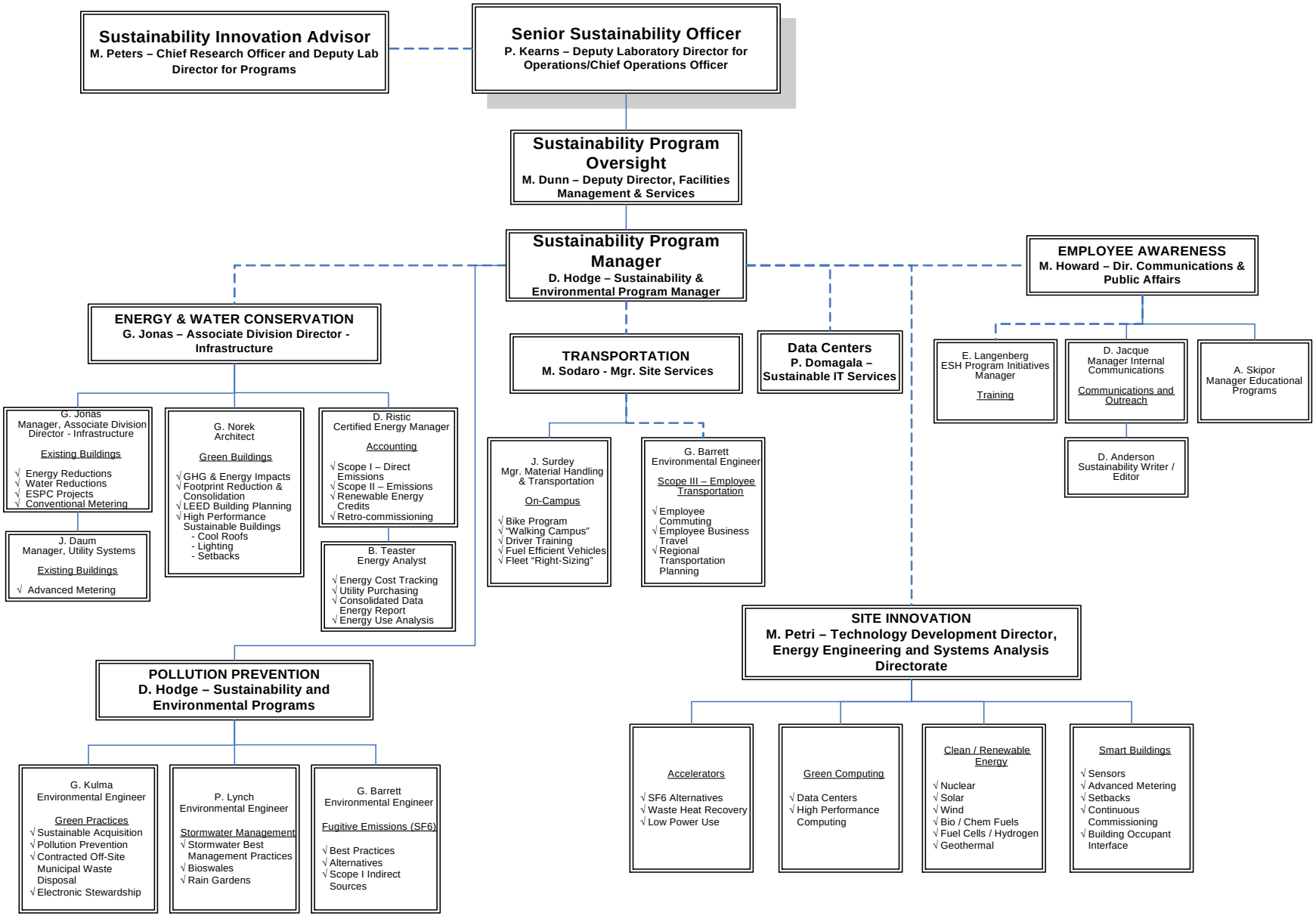


Figure 4-2: Argonne National Laboratory Sustainability Program

5.0 High-Energy Mission-Specific Facilities (HEMSFs)

This section provides a description and baseline tracking of Argonne HEMSFs, which are defined in the 2011 SSPP as:

> Constructed, mission-specific facilities, such as accelerators (particle and light sources), reactors (fusion and fission), high performance computers, high performance lasers and similar facilities and the closely coupled conventional facilities necessary for their operations (i.e., operationally dependent) which are necessary to achieving the Departments mission goals. HEMSF represent unique and often world-leading, core-mission relevant, capabilities relative to other research apparatus funded by DOE, other government agencies and/or industry. Many of the HEMSF are user facilities effectively managed by DOE and used by scientists and engineers across the globe to conduct research and development.

Argonne has four HEMSFs – all of which are scientific user facilities – listed in the DOE Office of Science (SC) database. Image 5-1 identifies Argonne HEMSFs and locates them on the Argonne site.

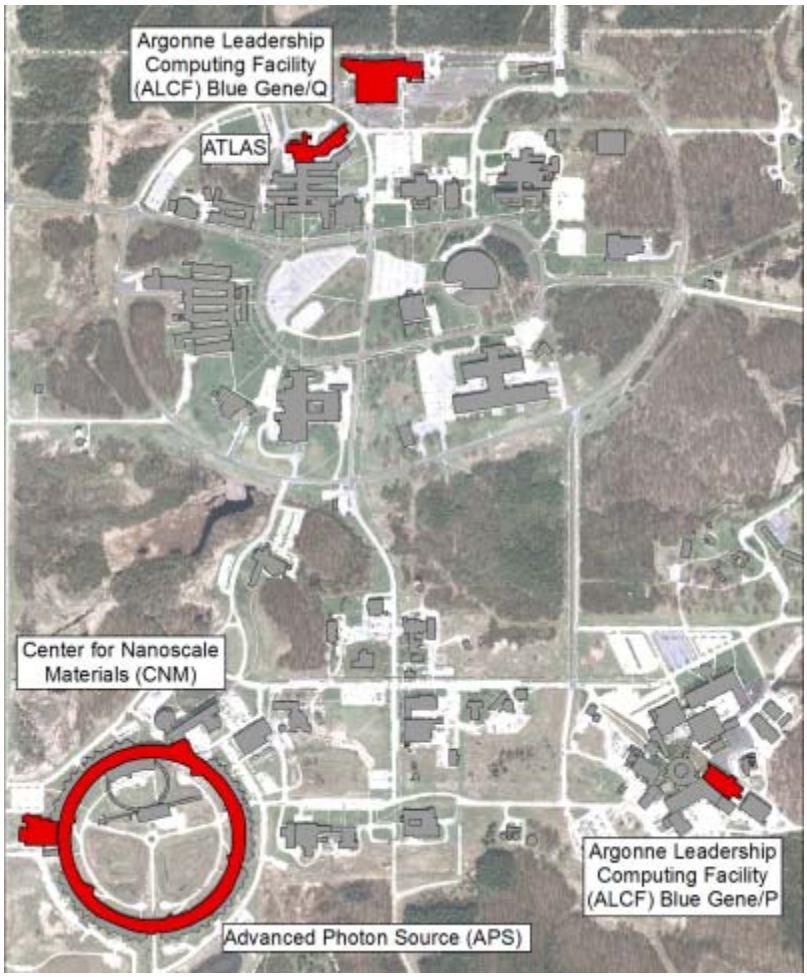
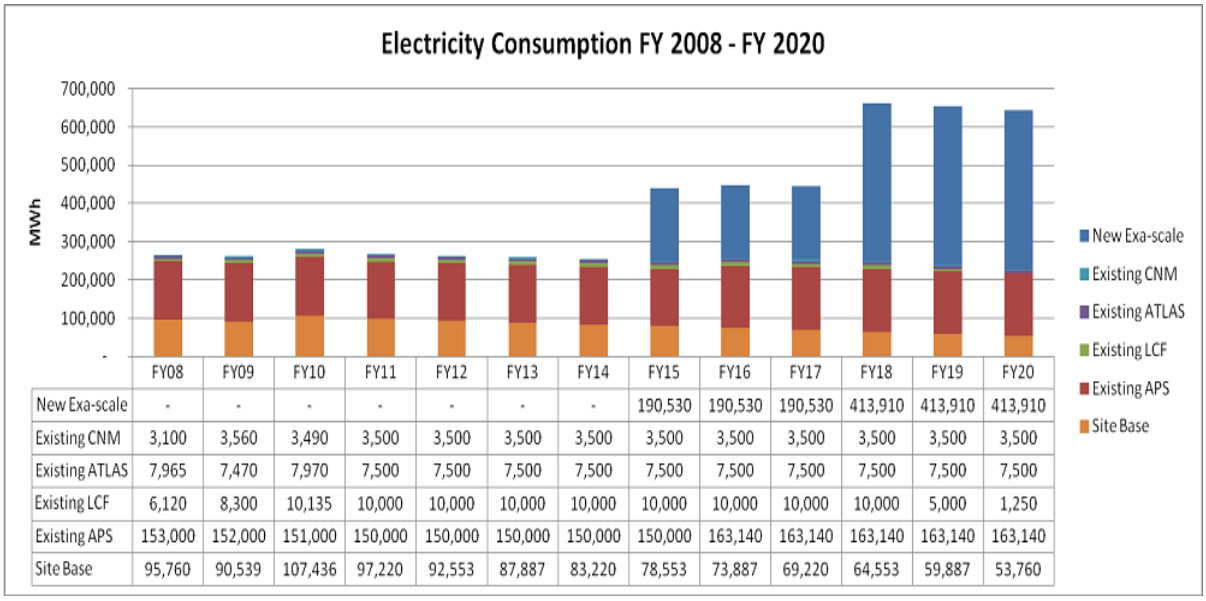


Image 5-1: Argonne HEMSFs

Cumulatively, the total HEMSF-related annual electricity consumption is approximately 170,000 MWh, comprising about 64% of total site electricity consumption. The HEMSF impact to electricity consumption is detailed in Figure 5-1.



	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
New Exa-scale	-	-	-	-	-	-	-	190,530	190,530	190,530	413,910	413,910	413,910
Existing CNM	3,100	3,560	3,490	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Existing ATLAS	7,965	7,470	7,970	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Existing LCF	6,120	8,300	10,135	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	5,000	1,250
Existing APS	153,000	152,000	151,000	150,000	150,000	150,000	150,000	150,000	163,140	163,140	163,140	163,140	163,140
Site Base	95,760	90,539	107,436	97,220	92,553	87,887	83,220	78,553	73,887	69,220	64,553	59,887	53,760

Figure 5-1: HEMSF Impact on Site-wide Electricity Consumption

5.1 Advanced Photon Source

Image 5-2: Advanced Photon Source

The APS is an accelerator that creates high-energy X-ray beams that allow scientists to pursue new knowledge about the structure and function of materials, promising to have far-reaching impacts on our technology, economy, and health, as well as our fundamental knowledge of the materials that make up our world.

Based on four findings listed in National Energy Conservation Policy Act (NECPA), the APS is considered an excluded building, under criterion “G” (“Metered intensive load”). The APS storage ring has an annual electricity consumption of 110,000 MWh (about a half of total Argonne electrical demand), and the dedicated APS utility facility (building 450) has an annual ring-related consumption of 40,000 MWh. Thus, total annual APS-related electricity consumption is approximately 150,000 MWh. Image 5-2 is an aerial photograph of the APS.

5.2 Argonne Leadership Computing Facility

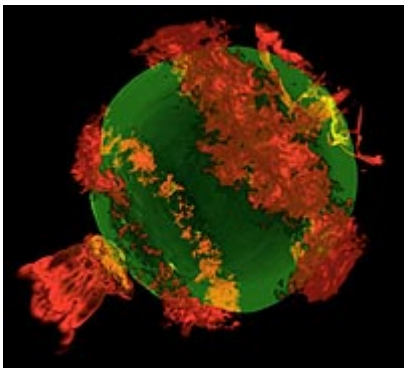


Image 5-3: Visualization Performed at the ALCF

The ALCF provides leadership-class computing resources. The ALCF's mission is to accelerate major scientific discoveries and engineering breakthroughs for humanity by designing and providing world-leading computing facilities in partnership with the computational science community. The ALCF houses one of the fastest open-science supercomputers in the world, the IBM Blue Gene/P Intrepid, which operates at 557 teraflops.

Based on four findings listed in the NECPA, the ALCF is considered an excluded building, under criterion “G” (“Metered intensive load”). Annual ALCF-related electricity consumption is about 10,000 MWh. A visualization performed at the ALCF is shown as Image 5-3.

5.3 Argonne Tandem Linear Accelerator System

The Argonne Tandem Linear Accelerator System (ATLAS) is a facility for fundamental nuclear physics research in the vicinity of the Coulomb barrier. It provides a wide range of beams for nuclear reaction and structure research. The full range of all stable ions can be produced in electron cyclotron resonance ion sources, accelerated to energies of 7-20 MeV per nucleon, and delivered to one of several target stations instruments with detector systems. About 20% of the beam time is used to generate secondary radioactive beams to study nuclear reactions of astrophysical interest and for nuclear structure investigations.

Image 5-4: Gammasphere at ATLAS

ATLAS is located in building 203. Based on four findings listed in the NECPA, ATLAS could be considered an "excluded" facility. However, electric power is supplied to ATLAS through five substations, which also supply electric power to building 203. Since ATLAS-related consumption is not an "overwhelming" proportion of building 203 consumption, the whole building 203 (including ATLAS) is considered "goal-subject." Argonne plans to start metering ATLAS separately as part of the metering program, which would enable exempting that part of goal-subject building 203, allowing ATLAS to be considered an excluded building under criterion "G." Annual ATLAS-related electricity consumption is approximately 7,500 MWh. The ATLAS Gammasphere target station is shown in Image 5-4.

5.4 Center for Nanoscale Materials

The CNM is a facility for interdisciplinary nanoscience and nanotechnology research. The CNM's goal is to support basic research and the development of advanced instrumentation that generates new scientific insights for the discovery, processing, characterization, and modeling of innovative nanoscale materials.

Based on four findings listed in NECPA, CNM is considered an excluded building, under criterion "G" ("Metered intensive load"). CNM-related annual consumption is approximately 3,500 MWh. A photograph of the CNM is provided as Image 5-5.

Image 5-5: Center for Nanoscale Materials

6.0 Adding Supply and Purchasing Renewable Energy Credits

Figure 6-1 shows Argonne's projected GHG emissions (in MT CO_{2e}) after factoring in planned growth as well as planned reduction initiatives.

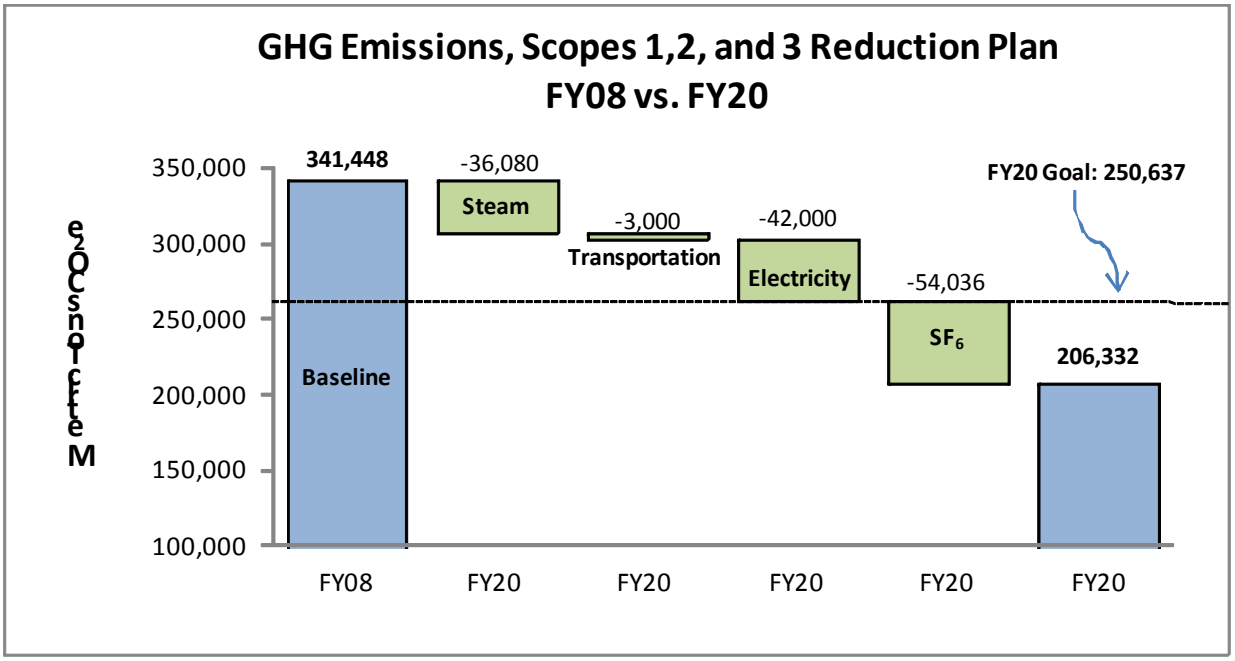


Figure 6-1: Projected GHG Emissions, FY2008 to FY2020

To offset the growth, especially that related to exascale computing, the laboratory is considering three options. The first, and most desirable from a sustainability standpoint, would be to generate the power on site. The second-best option would be to obtain the power through a dedicated power purchase agreement for clean or renewable energy. The third and least-desirable option would be to purchase RECs. The following sections discuss those three options.

6.1 On-site Power Production

As explained in Section 2.1.2, Argonne is evaluating a number of renewable energy production alternatives, including wind, solar, geothermal, and biofuels. At this time, specific information on costs and sizes of systems is still in development; however, initial projections are in excess of $70 million for a 10 to 15-MW solar or wind energy system. Argonne is continuing discussions with NREL and FEMP to update previous studies on on-site renewable energy conducted in 2008. The FY2013 SSP is expected to provide much firmer estimates and plans for on-site renewable energy production.

The CHP plant scheduled for FY2013 construction is anticipated to provide 5.8 MW of electric power; however, that is much less than is needed to support major high-performance computing programs. Due to Argonne's heat demand, it is not practical to increase the size of the CHP for higher power production.

6.2 Purchasing Off-Site Dedicated Renewable or Carbon-Free Electricity

Argonne is aggressively pursuing a study of the feasibility of power purchase agreements or other contractual arrangements with local or regional clean and renewable power producers. Presently, credit for such purchases cannot be taken due to regulations requiring use of e-Grid

emission factors for electricity purchase. Argonne has drafted a white paper on an alternative approach and is acting as the DOE-SC site champion for this issue. A number of wind and nuclear power providers in the area could be a good fit for a dedicated power purchase arrangement.

In FY2011, Argonne held discussions with a local utility-scale wind power firm that owns a wind farm in Stephenson County, Illinois. Discussion surrounded a power purchase agreement with a possible integrated experimental energy storage device to aid research in this area of Argonne core competence. Exelon Corporation, Argonne's power provider since February 2011, has already established an "Emissions Free Energy Certificate" program that the laboratory could take advantage of. Argonne has contracted with NREL to perform a revised renewable energy assessment in FY2012. These options are Argonne's second preference to support future HEMSF growth.

6.3 Purchasing Renewable Energy Credits

To assist DOE in meeting its renewable energy goals, Argonne purchased RECs equal to 7.8% of electricity consumption in FY2011 from a biomass energy producer. The plan is to continue this rate of REC purchase in FY2012. Outyear planning of REC purchases is shown in Table 6-1, utilizing a 10%[4] annual escalation rate. A potential cap-and-trade policy was not considered. Electricity intensity reduction is based on Table 1-4.

Table 6-1: Planned Purchases of RECs (costs for FY2011 are actual, all other costs are estimates)

Year	RECs (MWh)	Cost per REC ($/MWh)	Total Purchase ($k)
FY2011 (actual)	21,000	0.45	9.5
FY2012 (estimated)	20,552	0.49	10.1
FY2013 (estimated)	20,104	0.54	10.9
FY2014 (estimated)	19,656	0.59	11.6
FY2015 (estimated)	19,207	0.65	12.5
FY2016 (estimated)	18,759	0.72	13.5
FY2017 (estimated)	18,311	0.79	14.5
FY2018 (estimated)	17,863	0.87	15.5
FY2019 (estimated)	17,415	0.96	16.7
FY2020 (estimated)	16,967	1.05	17.8

As discussed previously, power demands are expected to dramatically increase with the installation of exascale computing system facilities scheduled for FY2015 and FY2018. Although the preferred choice would be to offset GHG emissions through on-site production of renewable energy, REC purchases will likely be pursued as the GHG offset mechanism, since they are relatively affordable compared to construction of wind or solar systems.

[4] For planning purposes, REC prices are projected to increase 10% annually. Prices will likely be highly influenced by state renewable portfolio standard requirements and any state or federal legislation for greenhouse gas emissions.