Fermilab

2018 Site Sustainability Plan

U.S. DEPARTMENT OF ENERGY | Office of Science

Fermi Research Alliance LLC

FERMI NATIONAL ACCELERATOR LABORATORY
FY 2018 SITE SUSTAINABILITY PLAN

U.S. Department of Energy
Sustainability Performance Office

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Executive Summary

FY 2017 marked the 50th anniversary of Fermi National Accelerator Laboratory which was celebrated throughout the year with activities highlighting the Laboratory's scientific and cultural achievements. Celebrations culminated in a public open house where 10,000 members of the public joined Fermilab staff for behind-the-scenes demonstrations of the Laboratory's world-class science. One of the consistent themes throughout the year was a look back at Fermilab's focus on pioneering research alongside the physical pioneering landscape restored and preserved during the Laboratory's first five decades.

Fermilab's Strategic Plan recognizes the laboratory's next fifty years as a place where more than 2,600 users drive discovery in particle physics by building and operating world-leading accelerator and detector facilities, performing pioneering research with national and global partners, and developing new technologies for science that support U.S. industrial competitiveness. Fermilab's science strategy for the future delivers on the U.S. particle physics community's goals as outlined in the Particle Physics Project Prioritization Panel's 2014 report (P5 report). The strategy's primary ten-year goal is to establish a world-leading neutrino science program anchored by the Long-Baseline Neutrino Facility (LBNF) and Deep Underground Neutrino Experiment (DUNE).

In FY 2017 Fermilab recommitted to an environmentally sound and sustainable future. The laboratory's commitment to environmental and sustainability stewardship is a main theme of the Fermilab Campus Master Plan, the next version of which will be finalized in FY 2018. Fermilab also conducted a climate vulnerabilities screening analysis to better understand how changing climate conditions are likely to affect the site's conventional and experimental infrastructure. Last, in FY 2017 Fermilab developed a site operational risk register which provides a basis to capture, quantify and track risks and impacts to the Laboratory's operations including sustainability and environmental impacts.

Photo: Visitors at Fermilab's 50th Anniversary Open House Participate in Demonstrations of Behind-the-Scenes World-Class Science

In FY 2017, Fermilab achieved success in meeting the laboratory's sustainability goals. The following accomplishments are notable examples of sustainability progress which support Fermilab's ability to deliver on its mission.

- The laboratory's Sustainability Management Team was re-chartered and now includes Sustainability Goal Owners to build expertise in developing and delivering projects to meet Fermilab's sustainability goals.
- Fermilab utilized an Illinois public sector retro-commissioning & energy assessment program to complete four retro-commissioning and energy audit projects yielding a list of energy conservation measures totaling 9,124 MWh and 94,034 therms annually.
- Modernization of Fermilab's Industrial Cooling Water system backbone through a Science Laboratories Infrastructure (SLI) project was substantially complete in FY 2017. Over 4 miles of new and replacement pipe infrastructure will significantly improve the reliability and efficiency of the ICW system.
- The Sustainability Management Team oversaw efforts to maximize waste diversion and communicate a message of environmental stewardship by deploying and monitoring 3-bin landfill/recycling/compost waste container groups at the Fermilab 50th anniversary public open house.
- Fermilab fleet management staff began using vehicle telematics to track and analyze fleet vehicle use and trip characteristic data.
- Fermilab installed its first two electric vehicle charging stations which will enable the charging of both fleet and personal employee vehicles under a new "Employee Electric Vehicle Charging" policy and procedure.
- Four new High Performance Sustainable Buildings (HPSB) were added to Fermilab's portfolio, more than doubling the laboratory's inventory of HPSB facilities in a single year.
- For the seventh year in a row, the Fermilab Grid Computing Center was awarded Energy Star status for its superior energy performance.
- Fermilab completed a climate change vulnerabilities screening which helped identify those assets and systems most vulnerable to the region's most likely climate impacts.

This Site Sustainability Plan (SSP) describes progress toward meeting Fermilab's sustainability goals and supporting the laboratory's mission. Fermilab's progress is captured in the following scorecard summary.

Scope 1 & 2 Greenhouse Gas Emissions
Goal: Reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline. Interim Target (FY 2017): -25.0 %

Baseline: 384,366.1 MtCO2e

Current Performance: -61.7% (147,287.9 MtCO2e)

Scope 3 Greenhouse Gas Emissions
Goal: Reduce indirect GHG emissions by 25 percent by FY 2025 relative to FY 2008 baseline. Interim Target (FY 2017): -9.0 %

Baseline: 29,502.4 MtCO2e

Current Performance: -68.5% (9,304.4 MtCO2e)

Energy Intensity
Goal: Reduce facility energy in goal subject facilities by 30 percent relative to FY 2015 baseline. Interim Target (FY 2017): -5.0 %

Baseline: 90,637.3 Btu/GSF

Current Performance: -15.6% (76,541.2 Btu/GSF)

Renewable Energy
Goal: Use 30 percent renewable energy as a percentage of overall facility electricity use by FY 2025. Interim Target (FY 2017): 10.0 %

Baseline: 279,647.0 MWh

Current Performance: 14.3% (40,012.2 MWh)

Potable Water Intensity
Goal: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline. Interim Target (FY 2017): -20.0 %

Baseline: 12.2 gal/GSF

Current Performance: -24.3% (9.2 gal/GSF)

Fleet Petroleum
Goal: Reduce fleet petroleum use by 20 percent by FY 2015 and thereafter relative to FY 2005 baseline. Interim Target (FY 2017): -20.0 %

Baseline: 82,267.0 GGEs

Current Performance: -65.9% (28,078.9 GGEs)

High Performance Sustainable Buildings
Goal: Ensure 15 percent (18 percent by GSF) of buildings meet the Guiding Principles for sustainable buildings by FY 2025. Interim Target (FY 2017): 15.0 %

Baseline: 103.0 Buildings

Current Performance: 6.8% (7.0 Buildings)

Fleet Greenhouse Gas Emissions/Mile
Goal: Reduce per-mile greenhouse gas emissions by 30 percent by FY 2025 relative to FY 2014 baseline. Interim Target (FY 2017): -4.0 %

Baseline: 0.5 GHG/Mile

Current Performance: -13.3% (0.4 GHG/Mile)

Energy Management

Energy Management: Scope 1 & 2 Greenhouse Gas Reduction

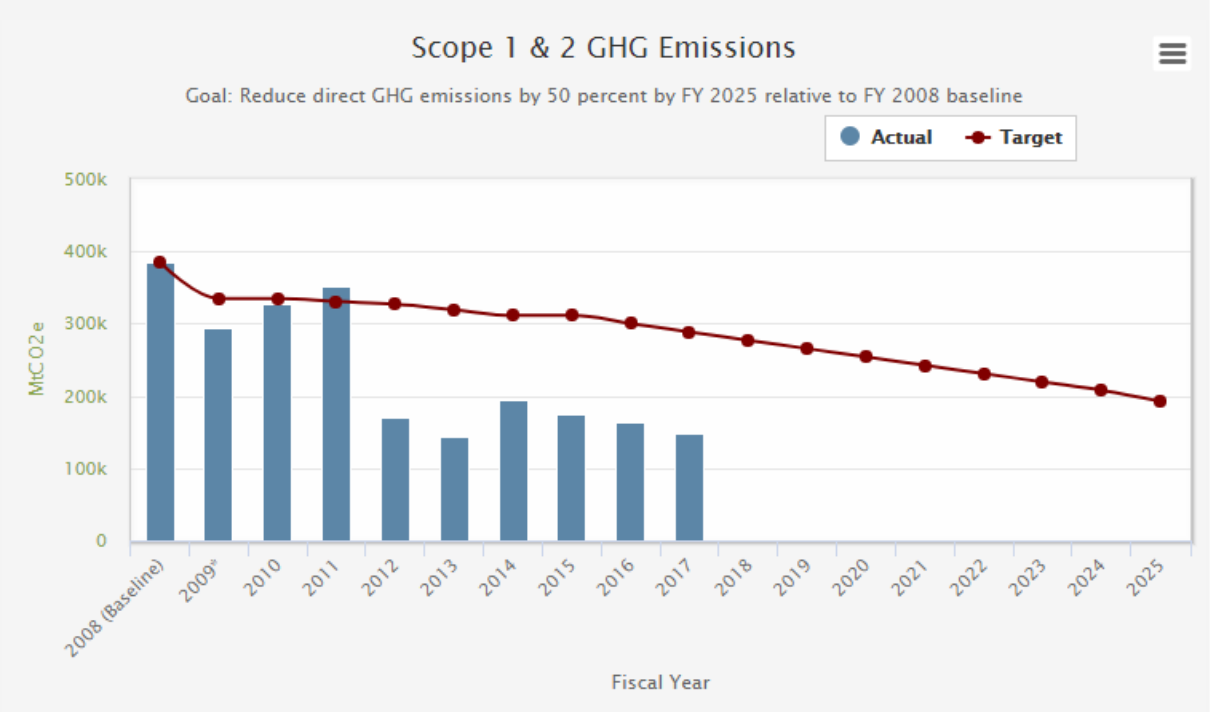
Performance Status

Scope 1 & 2 Greenhouse Gas Emissions

Goal: Reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline. Interim Target (FY 2017): -25.0 %

Current Performance: -62%

	FY 2008	FY 2017	% Change
Facility Energy	343,366.8	181,073.1	-47.3%
Non-Fleet V&E Fuel	142.6	181.9	27.6%
Fleet Fuel	691.6	300.6	-56.5%
Fugitive Emissions	40,165.1	1,362.6	-96.6%
On-site Landfills	0.0	0.00	N/A
On-site WWT	0.0	0.00	N/A
Renewables	0.0	0.00	N/A
RECs	0.0	-35,630.4	N/A
Total (MtCO2e)	**384,366.1**	**147,287.9**	**-61.7%**



A vast majority of Fermilab's Scope 1 & 2 greenhouse gas emissions in FY 2017 were produced during the generation of electric power required to operate the laboratory's high energy mission specific facilities (HEMSFs). The largest decrease in scope 1 & 2 greenhouse gas emissions since the FY 2008 baseline year is due to the decommissioning of the Tevatron accelerator in FY 2011. The decrease in FY 2017 was due in large part to an extended accelerator shutdown. The FY 2017 accelerator shutdown yielded a reduction in energy consumption and related generation of greenhouse gas emissions.

Energy efficiency improvements to conventional facilities (and therefore Scope 1 & 2 emissions reductions) are described below (Section: Energy Intensity).

Plans and Projected Performance

The possibility of an extended accelerator shutdown in FY 2018 may continue to hold down the purchased electricity greenhouse gas emissions contribution. Fermilab will also continue to carry out energy efficiency projects in FY 2018 as part of regular campus utility and facility improvement programs. Renewable energy credits will then be utilized to meet the FY 2018 goal.

Energy Management: Scope 3 Greenhouse Gas Reduction

Performance Status

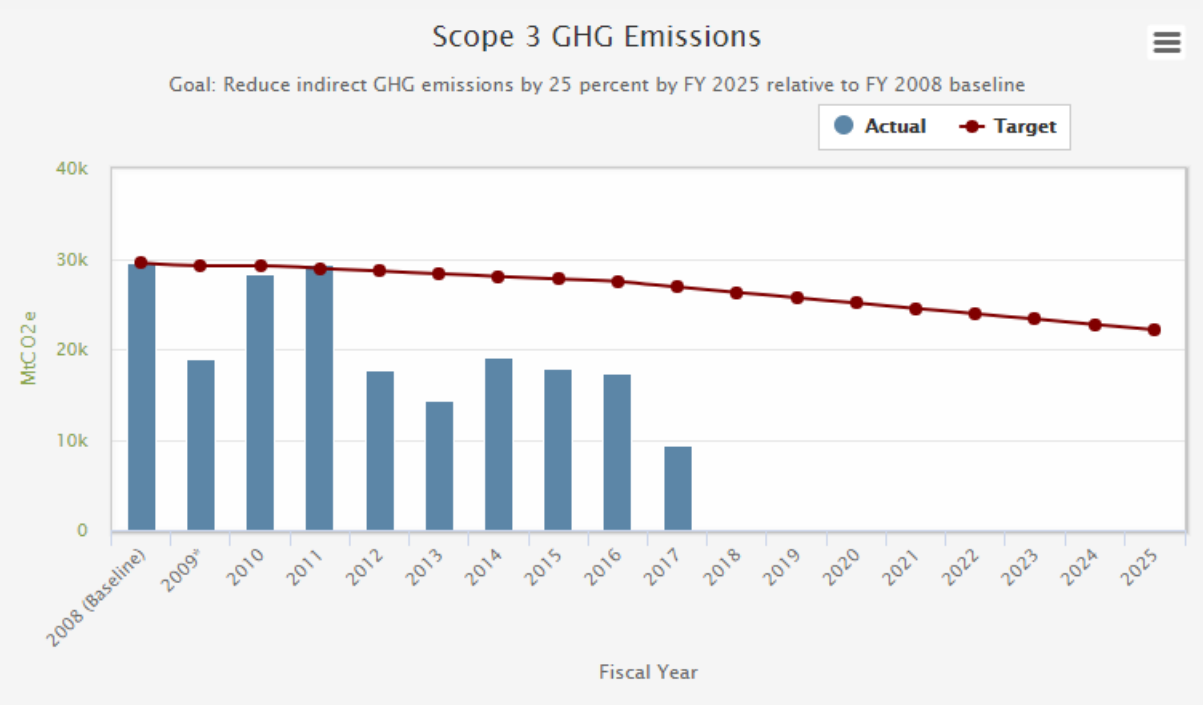
Scope 3 Greenhouse Gas Emissions

Goal: Reduce indirect GHG emissions by 25 percent by FY 2025 relative to FY 2008 baseline. Interim Target (FY 2017): -9.0 %

Current Performance: -69%

	FY 2008	FY 2017	% Change
T&D Losses*	22,287.8	2,177.7	-90.2%
Air Travel	2,215.8	2,533.0	14.3%
Ground Travel	168.9	90.6	-46.4%
Commute	4,633.3	4,285.3	-7.5%
Off-site MSW	191.8	208.7	8.8%
Off-Site WWT	4.8	9.0	87.5%
Total (MtCO2e)	**29,502.4**	**9,304.4**	**-68.5%**

* Includes T&D losses for purchased renewable electricity and T&D credits from RECs



Emissions from transmission & distribution losses from purchased electricity was the third largest contributor to Fermilab's Scope 3 emissions in FY 2017. Emissions dropped from FY 2016 to FY 2017. Transmission and distribution losses fell in line with the FY 2017 extended accelerator shutdown and associated reduction in purchased electricity. Fermilab also realized an adjustment to the transmission and distribution factor in FY 2017 to more closely reflect actual conditions. Energy efficiency improvements to conventional facilities (and therefore Scope 3 emissions reductions) are described below (Section: Energy Intensity).

Plans and Projected Performance

The possibility of an extended accelerator shutdown in FY 2018 may continue to hold down the purchased electricity transmission and distribution greenhouse gas emissions contribution. Fermilab will continue to pursue activities which reduce overall site energy consumption and therefore Scope 3 emissions from transmission and distribution losses. Renewable energy credits will then be utilized to meet the FY 2018 goal.

Energy Management: Energy Intensity Reduction

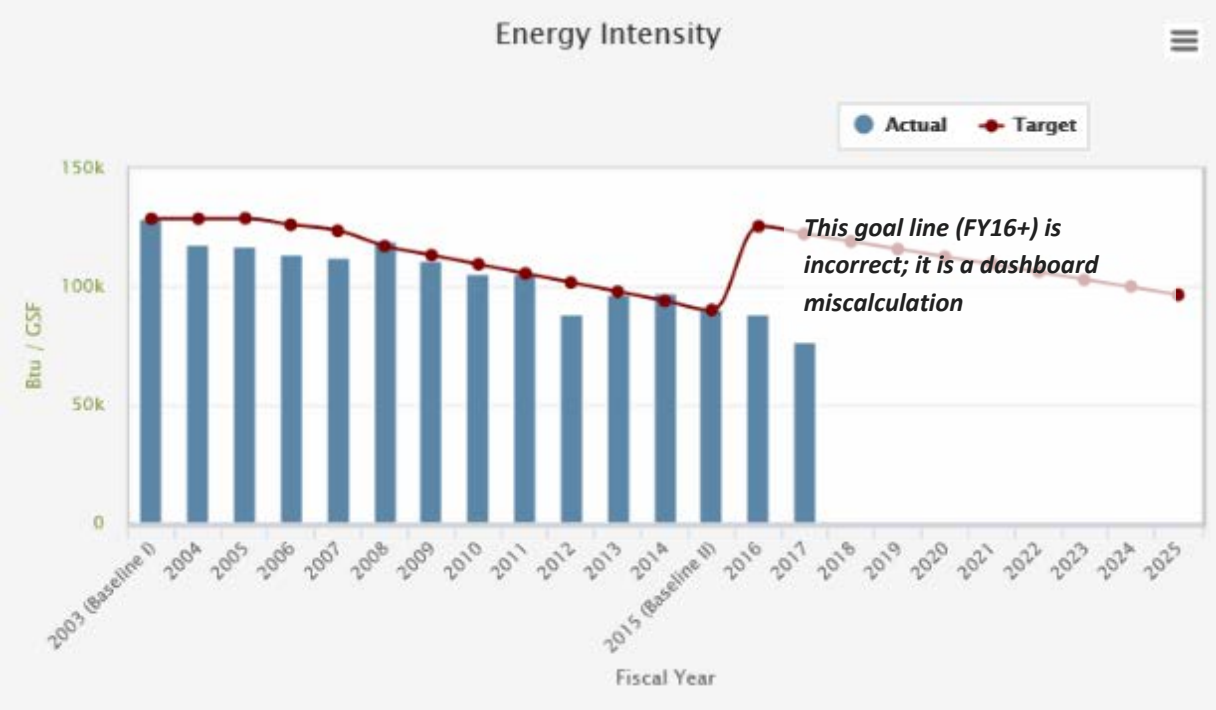
Performance Status

Energy Intensity

Goal: The latest energy intensity reduction goal, requires a reduction in energy intensity for goal subject facilities by 25 percent by FY 2025 relative to FY 2015 baseline. The prior goal, required a 30 percent reduction by FY 2015 relative to FY 2003 baseline. Interim Target (FY 2017): -5.0 %

Current Performance: -16%

	FY 2015	FY 2017	% Change
Purchased Utilities (MMBtu)	95,494.3	80,644.0	-15.6%
Purchased Renewables (MMBtu)	0.0	0.0	N/A
Goal-subject GSF	1,053,588.0	1,053,603.0	0.0%
Energy Intensity (Btu/GSF)	**90,637.3**	**76,541.2**	**-15.6%**



Fermilab completed energy efficiency improvements to its conventional facilities which also contributed to a reduction in overall facility energy intensity. The improvements included decommissioning of pond pumps, replacement of large shell & tube heat exchangers with a small plate and frame heat exchanger, and installation of variable frequency drives to improve efficiency of pumps in our central campus area.

In addition, the Energy Intensity goal allows a credit for reductions to energy consumption in high energy mission specific facilities (HEMSFs.) With an extended accelerator shutdown in FY 2017, the credit for process energy reduction led to an improved reduction from energy efficiency enhancements in conventional facilities alone.

Fermilab participated in an energy curtailment program as negotiated with the laboratory's utility provider in FY 2017. The demand reduction exercise yielded $348K in target reduction accomplishment compensation.

Plans and Projected Performance

Recent Illinois state legislation has removed Fermilab and other high energy-consuming customers from its public energy efficiency incentive program. However, Fermilab is investigating the potential to develop an in-house energy efficiency reinvestment program. An in-house program would enable Fermilab staff to incentivize and fund energy efficiency facility and asset repairs and replacements.

In FY 2018 Fermilab will also participate in the Department of Energy's Facilities and Infrastructure Restoration and Modernization Program. Staff from the National Renewable Energy Laboratory (NREL) will visit Fermilab to assess the potential for deep energy efficiency retrofits of facilities as well as other energy intensity reduction measures.

Energy Management: EISA Evaluations

Performance Status

Goal: Evaluate all facilities that constitute at least 75% of Fermilab's total energy use every four years

2017 Actual: 47% of facilities that consume 75% of Fermilab's total energy use are complete (1,635,360 gsf complete, 1,814,674 gsf remaining.)

FY 2017 was the beginning of a new 4-year cycle of EISA energy evaluations for goal-subject buildings. Fermilab participated in Illinois' Smart Energy Design Assistance Center (SEDAC) public sector retro-commissioning & energy assessment program. Two retro-commissioning projects & two energy audits were performed, yielding a list of energy conservation measures totaling 9,123,995 kWh and 94,034 therms annually. Additionally, Fermilab contracted for an energy study of the site's central utility building. In total, the retro-commissioning and energy audits covered 15 buildings and 839,608 gsf. Desk audits comprised the reminder of FY 2017 assessments. At the end of the first year of the current 4-year cycle, therefore, Fermilab is ahead of schedule with 47% of EISA evaluations complete.

Plans and Projected Performance

Fermilab will continue to perform energy and water evaluations of goal-subject facilities to complete all facilities every four years.

Energy Management: Metering Status

Performance Status

Goal: Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate

2017 Actual: Progressing toward building-level metering; ICW meters were installed at most cost-effective locations; plans developed for deployment of natural gas meters; planning underway for building-level electric meters (beyond new facilities)

In FY 2017, Fermilab completed installation of industrial cooling water (ICW) meters at 29 facilities which comprises 100% of the site's process ICW connections. This project complements the recent Science Laboratories Infrastructure (SLI) ICW upgrade project by adding visibility into ICW consumption. This will enable a greater understanding about how ICW is utilized throughout the laboratory complex and the ability to identify and isolate inappropriate consumption or leaks. ICW consumption will be analyzed for potential savings opportunities. Fermilab staff also prepared plans in FY 2017 for deploying natural gas meters in FY 2018.

Plans and Projected Performance

As part of Fermilab's campus modernization efforts, aging and failing natural gas meters will be replaced with smart meters. In FY 2018, Fermilab will evaluate meters that will properly interface with the laboratory's supervisory control and data acquisition (SCADA) system. In addition, in FY 2018 and FY 2019 Fermilab will be developing a Utility Infrastructure Plan which will lead to a more cohesive approach to installing and maintaining metering infrastructure.

Photo: Utility meters installed at Fermilab's Illinois Accelerator Research Center (IARC)

Water Management

Water Management: Potable Water Use Reduction

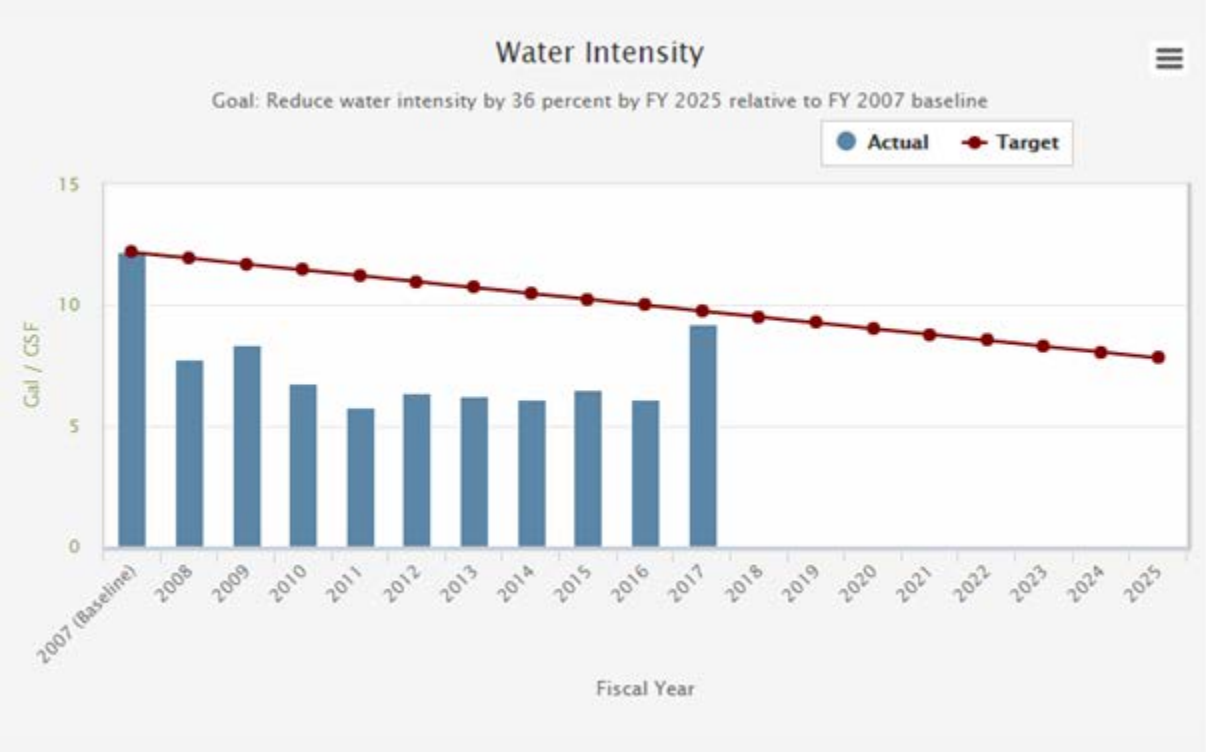
Performance Status

Potable Water Intensity

Goal: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline. Interim Target (FY 2017): -20.0 %

Current Performance: -24%

	FY 2007	FY 2017	% Change
Water Consumption (million gal)	41.4	32.0	-22.7%
Aquifer Recharge (million gal)	0.0	0.0	N/A
Total GSF	3,398,290.0	3,474,214.0	2.2%
Water Intensity (Gal/GSF)	**12.2**	**9.2**	**-24.6%**



Fermilab achieved the interim potable water intensity reduction goal. However, a large and persistent domestic water site leak caused an increase in domestic water use from FY 2016 levels. Extraordinary effort was necessary to locate and execute corrective action as it was found beneath the foundation of an existing building. The FY 2017 leak was successfully repaired, and an immediate domestic water reduction was observed through Fermilab's continuous domestic water monitoring system. Conventional potable water reduction measures include specifying water efficient fixtures in all new construction and renovation projects.

Plans and Projected Performance

Fermilab remains on track to meet the potable water intensity reduction goal in FY 2018. Plans for FY 2018 include replacement of domestic water mains in areas which are known sources of water breaks and leaks. Conventional potable water reduction measures will continue to be deployed in FY 2018 including specifying water efficient fixtures in all new construction and renovation projects. In FY 2018 and FY 2019 Fermilab will also develop a Utility Infrastructure Plan which will identify and prioritize necessary system improvements.

Water Management: Industrial Landscaping and Agricultural Water Reduction

Performance Status

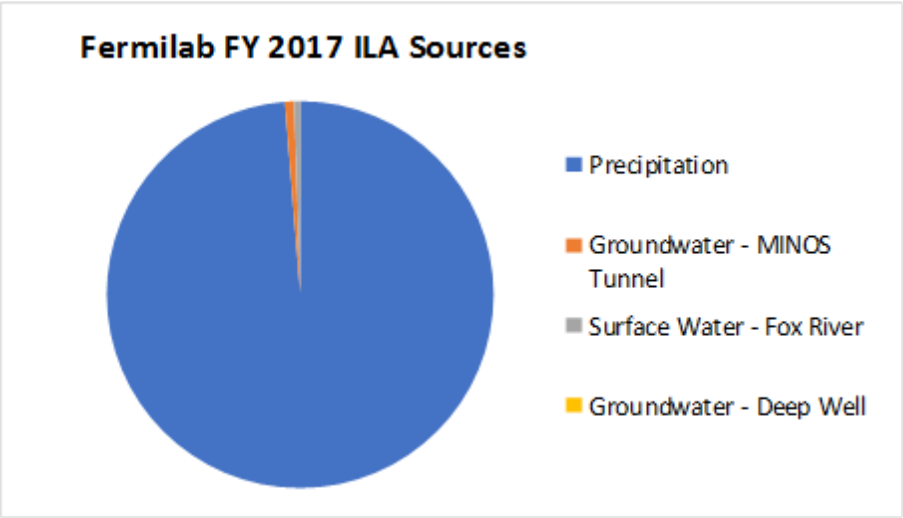
Industrial, Landscaping, Agricultural Water

Goal: Reduce industrial, landscaping and agricultural water use by 30 percent by FY 2025 relative to FY 2010 baseline. Interim Target (FY 2017): -14.0 %

Current Performance: 4.7%

	FY 2010	FY 2017	% Change
Industrial	81.3	85.1	4.7%
Landscaping	0.0	0.0	N/A
Agricultural	0.0	0.0	N/A
Total ILA Water (million gal)	**81.3**	**85.1**	**4.7%**

Virtually all Industrial, Landscaping and Agricultural (ILA) water used at Fermilab is contained in a semi closed-loop, surface and piped, Industrial Cooling Water (ICW) system to provide cooling for the accelerator complex. Water for the ICW system is obtained principally from precipitation which is considered an alternative water source and therefore not subject to efficiency goals. Precipitation is not accounted for in Fermilab's ILA consumption records. Precipitation is supplemented by ground and surface makeup water which comprise the target for ILA reduction goals. Since precipitation is not part of the ILA accounting process, slight increases or decreases to the makeup water sources lead to exaggerated goal impacts.



ILA water use accounted for during FY 2017 was the sum of the supplemental sources, and was 5% higher than the FY 2010 baseline year. The increase in makeup water can be partially attributed to a leak in the Fox River makeup water distribution system which is currently under design for repair in FY 2018.

However, several projects were completed in FY 2017 which will improve the efficiency of the ICW system. Fermilab's Science Laboratories Infrastructure (SLI) ICW improvement project was substantially complete in FY 2017, providing a new piped backbone to reduce leaks and improve transmission efficiency. This $18M investment in Fermilab's underground water distribution system replaced or installed 4 miles of new pipe to provide significantly more efficient transmission of ICW across the site.

In addition, an ICW metering project installed 35 meters at 29 facilities with process ICW connections. These meters will allow staff to see in real time and make recommendations to optimize and curtail use in alignment with accelerator complex needs. Several ICW branch repairs were also made in FY 2017 which will reduce consumption going forward.

Fermilab has a site-wide strategy of natural landscaping and native grassland management that requires a minimum amount of landscape or agricultural watering. Minor amounts of ICW are used during times of drought to water ornamental trees.

Plans and Projected Performance

In FY 2018 Fermilab will continue to take measures to increase the efficiency of the ICW system. ICW system leaks will be identified and repaired in a timely manner to minimize ILA losses.

Fermilab's ILA water is used for fire protection and to support High Energy Mission Specific (experimental) operations. The development of a Utilities Infrastructure Plan in FY 2018 and FY 2019 will provide Fermilab with a better understanding of future capacity needs and the identification and prioritization of needed repairs and replacements to the current system.

Photo: Repairs to Fermilab's ICW system are made routinely and improve sitewide ILA efficiency; this repair, made in FY 2017, replaced a leaking ICW pipe in the central campus

Waste Management

Waste Management: Municipal Waste Diversion

Performance Status

Municipal Solid Waste Diversion

Goal: Divert at least 50 percent of non-hazardous solid waste (excluding construction and demolition debris)

Interim Target (FY 2017): 50.0 %

Current Performance: 59%

	FY 2017	%
Off-Site Landfills	240.1	39.8%
On-Site Landfills	N/A	N/A
Waste to Energy*	6.8	1.1%
Non-diverted Waste	***246.9***	***40.9%***
Diverted Waste	354.0	58.7%
On-site composted	0.0	0.0%
Off-site composted	2.7	0.4%
Total Diverted Waste	***356.7***	***59.1%***
Total Waste (metric tons)	**603.6**	**100.0%**

* For E.O. 13693, waste to energy does not count as diverted waste

Fermilab has an established recycling program and actively seeks out opportunities to expand the program where it is feasible. Over 59% of Fermilab's waste was diverted from landfills in FY2017. This includes paper, plastic, and aluminum cans as well as scrap metal and other items such as alkaline batteries and polystyrene. The Fermilab cafeteria contractor has an established compost program for kitchen scraps that generated 2.7 tons taken off site for composting. The cafeteria contractor was new to Fermilab in FY 2017 and there was a gap in collecting compost during the transition months.

In FY 2017 Fermilab hosted an open house for 10,000 members of the public. Waste minimization was a goal for the event, and 3-bin waste container groups (landfill, recycling, compost) were deployed throughout the site for the event. In addition, Fermilab volunteers monitored the containers to ensure public participation and appreciation for the waste diversion effort.

Photo: FY 2017 Fermilab Open House Featured 3-Bin Waste Disposal

Plans and Projected Performance

Fermilab will continue to build aggressive waste minimization programs, including recycling and compost collection in the cafeteria. New signage will be deployed in FY 2018 in the cafeteria to assist in refuse sorting. Fermilab is exploring improvements to cafeteria disposables and the potential to add a reusable take-out container. The trash and recycling contract expires in 2018 and the request for proposals will request bids on composting hauling services.

Waste Management: Construction and Demolition Debris Diversion

Performance Status

Construction & Demolition Diversion

Goal: Divert at least 50 percent of construction and demolition materials and debris

Interim Target (FY 2017): 50.0 %

Current Performance: 86%

	FY 2017	%
Landfilled C&D Waste	53.2	14.4%
Diverted C&D Waste	316.4	85.6%
Total C&D Waste (metric tons)	**369.6**	**100.0%**

In FY 2017, Fermilab generated 370 short tons of construction and demolition waste, 86% of which was ultimately recycled. Fermilab had fewer large-scale active construction projects in 2017 compared to 2016.

Plans and Projected Performance

Fermilab maintains a clear set of requirements in all new construction specifications for construction and demolition debris recycling. As new construction and renovation projects are developed in future years, sustainability management team staff will continue to advocate for best practices in management of construction and demolition debris.

Fleet Management

Fleet Management: Emissions Reduction, Petroleum Fuel Reduction

Performance Status

Fleet Greenhouse Gas Emissions/Mile

Goal: Reduce per-mile greenhouse gas emissions by 30 percent by FY 2025 relative to FY 2014 baseline

Interim Target (FY 2017): -4.0 %

Current Performance: -13%

	FY 2014	FY 2017	% Change
Fleet Fuel GHG (MtCO2e)	395.5	300.6	-24.0%
Fleet Miles (x1000)	823.7	722.3	-12.3%
Greenhouse Gas Emissions / Mile (gCO2e/Mile)	**480.0**	**416.0**	**-13.3%**

Fleet Petroleum

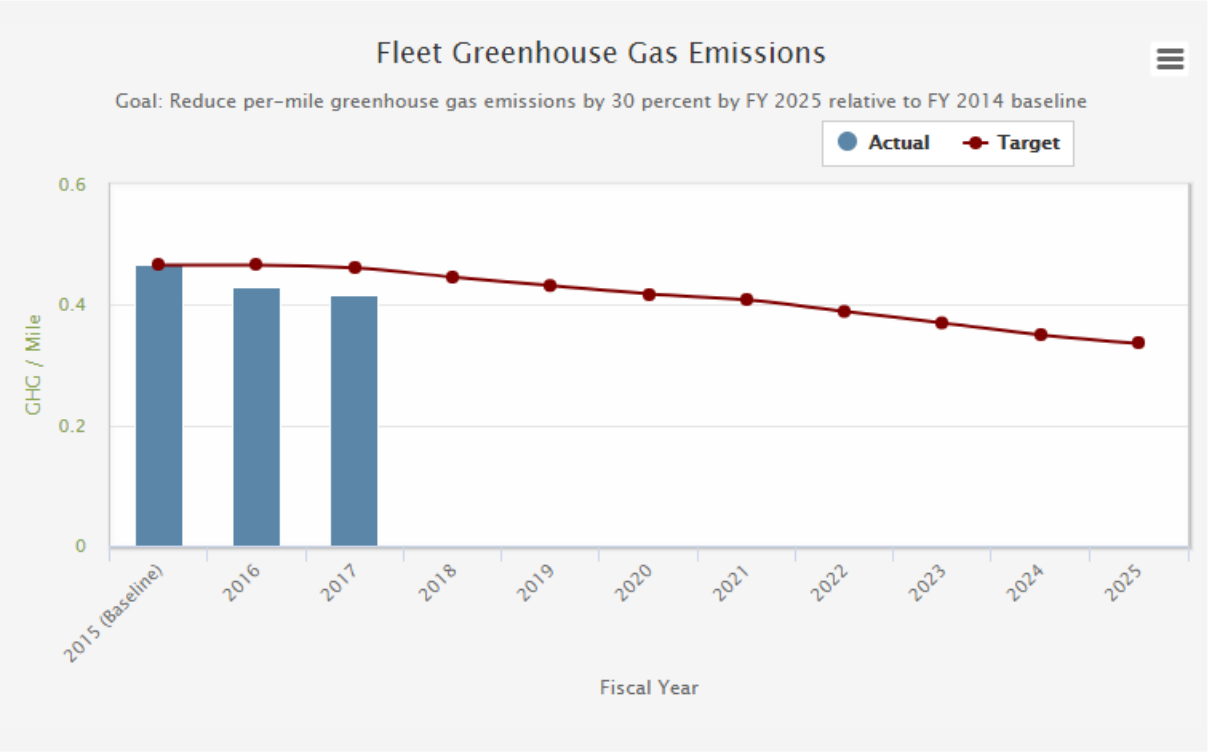
Goal: Reduce fleet petroleum use by 20 percent by FY 2015 and thereafter relative to FY 2005 baseline

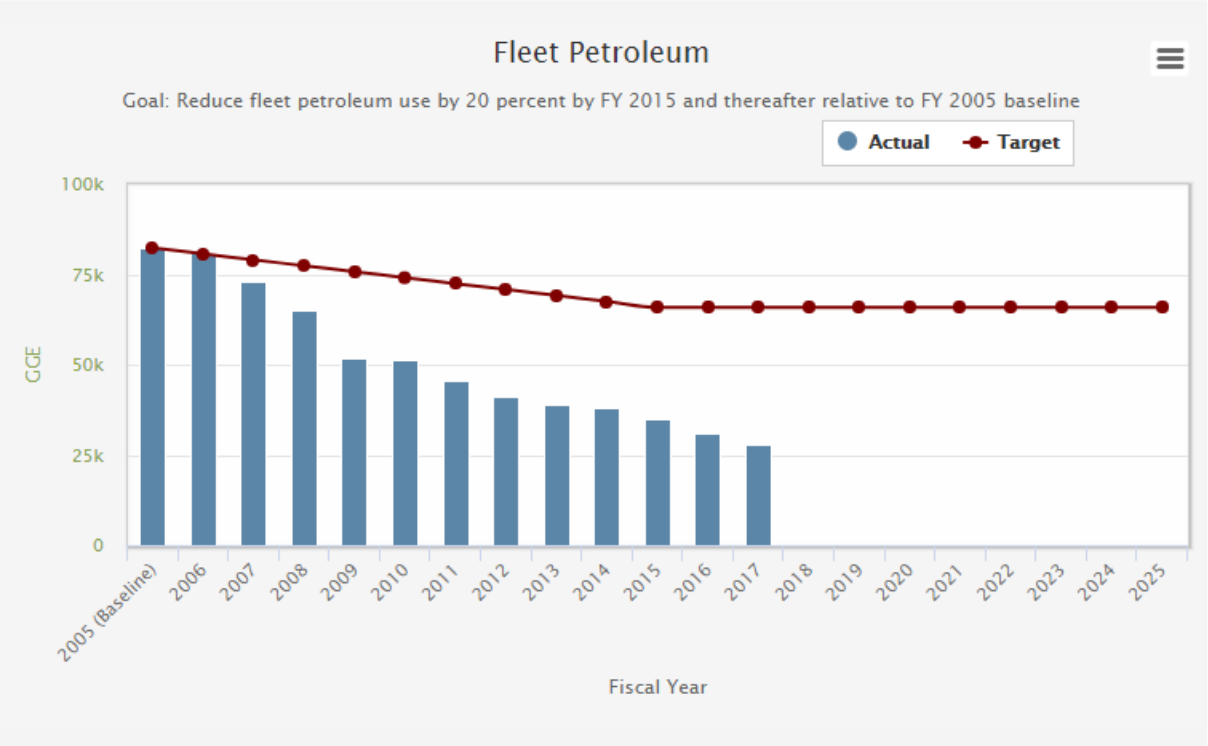
Interim Target (FY 2017): -20.0 %

Current Performance: -66%

	FY 2005	FY 2017	% Change
Gasoline	59,139	9,734	-83.5%
Diesel	23,128	0	-100.0%
Biodiesel*	0	18,345	N/A
Total Petroleum (GGE)	**82,267**	**28,079**	**-65.9%**

* Includes only the diesel content of B20





One of Fermilab's strategies in FY 2017 for reducing petroleum fuel use and increasing overall fleet efficiency was to use Verizon Networkfleet telematics on 13 vehicles. Although early in the system's deployment, staff have quickly gained valuable utilization, idle time, and speed data-based insights. This data is reviewed regularly during the laboratory's monthly fleet utilization committee meeting so vehicle users can monitor their team's driving patterns for potential efficiency improvements.

Plans and Projected Performance

An ongoing challenge in reducing fuel use and associated emissions lies in the balance of striving for trip efficiency while meeting local fleet vehicle use objectives (meeting minimum miles per vehicle requirements for fleet justification.) To address this challenge, in FY 2018 Fermilab is proposing to move to fleet utilization reporting using a trip counts metric in place of miles driven. Fermilab will increase the number of fleet vehicles using the newly deployed Networkfleet telematics package for utilization monitoring.

Fleet Management: Increase in Alternative Fuel Consumption and Alternative Fuel Vehicles

Performance Status

Fleet Alternative Fuel

Goal: Increase fleet alternative fuel use by 10 percent by FY 2015 and thereafter relative to FY 2005 baseline

Interim Target (FY 2017): 10.0 %

Current Performance: 46%

	FY 2005	FY 2017	% Change
E-85	15,020	33,413	122.5%
Biodiesel*	0	4,951	N/A
CNG	11,190	0	-100.0%
Other*	0	0	N/A
Total Alternative (GGE)	**26,210**	**38,364**	**46.4%**

* Biodiesel contains B100 plus the biodiesel content from B20. Other contains LNG, LPG, and electric

Fermilab has a strong history of utilizing both E85 fueled vehicles and B20 biodiesel fueled vehicles. Currently the fleet consists of 117 vehicles fueled with E85 fuel, 45 diesel vehicles utilizing B20 diesel fuel, and 12 hybrid vehicles. Fermilab purchased a plug-in hybrid (PIH) vehicle in late FY 2016 (Ford Fusion Sedan).

In FY 2017 Fermilab purchased and installed two Level II electric vehicle charging stations. Each station is a dual charging unit, which provides power to our current DOE owned PIH vehicle(s) and features a reimbursement function which enables the stations to provide power to private electric vehicles as well. In FY 2017, Fermilab adopted a policy and procedure which now enables employees to use the Fermilab fleet electric vehicle charging stations.

Plans and Projected Performance

In FY 2018 Fermilab will investigate the possibility of using renewable diesel which has a much lower gallon gas equivalent (GGE) value and has a reported superior performance than B20 diesel fuel. Currently this fuel is only available in southern states and California.

Historically, Fermilab has focused on acquiring alternatively fueled vehicles both in E85 and B20 fuels. In FY 2018 and beyond, the laboratory will replace conventional vehicles with electric or plug-in hybrid (PIH) vehicles whenever they are available in the configuration needed and within budget requirements. In addition, as Fermilab's inventory of PIH vehicles grows, additional electric vehicle charging stations will be added to the laboratory's campus.

Photo: One of two Level II electric vehicle charging stations installed at Fermilab in FY 2017

Clean & Renewable Energy

Performance Status

Clean Energy

Goal: By FY 2025, use 25 percent renewable energy as a percentage of overall facility electric and thermal energy use. Interim Target (FY 2017): 10.0 %

Current Performance: 14%

	FY 2017 Energy Consumption	FY 2017 Clean Energy w/ Bonuses	% of Total
Grid Electricity	954,135	0.00	N/A
Non-renewable Thermal Energy	87,699	0.00	N/A
On-Site Renewable Energy	2,349	4,697	200.0%
Purchased Green Electricity	0	0.00	N/A
Renewable Energy Certificates	N/A	136,480	N/A
Total (MMBtu)	**1,044,182**	**141,177**	**13.5%**

Renewable Electricity

Goal: By FY 2025, use 30 percent renewable energy as a percentage of overall facility electricity use. Interim Target (FY 2017): 10 %

Current Performance: 14%

	FY 2017 Electricity Consumption	FY 2017 Renewable Electricity w/ Bonuses	% of Total
Grid Electricity	279,641	0.00	N/A
On-Site Renewable Energy	6	12	N/A
Purchased Green Electricity	0	0.00	N/A
Renewable Energy Certificates	N/A	40,000	14.3%
Total (MWh)	**279,647**	**40,012**	**14.3%**

In FY 2017 Fermilab produced 6 MWH of clean and renewable energy. The Fermilab Office, Technical and Education building (FIMS 328) is heated and cooled by a geothermal well network and has exceeded its design output of 2,015.5 MMBTU per year with an output of 2,327.95 MMBTU. Fermilab purchased 40,000 MWH of renewable energy credits (RECs) in FY2017, equivalent to 14.3% of the site's total annual electric energy consumption. A photovoltaic array at the Lederman Science Education Center is used for educational purposes by visiting students. It consists of both photovoltaic and concentrating voltaic panels; output from this array increased 11% over FY 2016-FY 2017.

Photo: Lederman Science Center Photovoltaic Array

Photo: Fermilab's Illinois Accelerator Research Center utilizes geothermal heating and cooling to save electric and natural gas energy

Plans and Projected Performance

Solar photovoltaic, solar hot water heating and other clean and renewable systems are regularly considered for all new construction projects according to High Performance Sustainable Building Guiding Principles. Due to Fermilab's very low energy utility rates, renewables have not yet been found cost effective. Fermilab will continue purchasing RECs to meet Fermilab sustainability goals each year, until cost effective opportunities for renewable power generation are identified.

In FY 2018 Fermilab will explore onsite renewable energy production opportunities including through the DOE Facilities and Infrastructure Restoration and Modernization program.

Green Buildings

Green Buildings: High Performance Sustainable Buildings, Net Zero Buildings

Performance Status

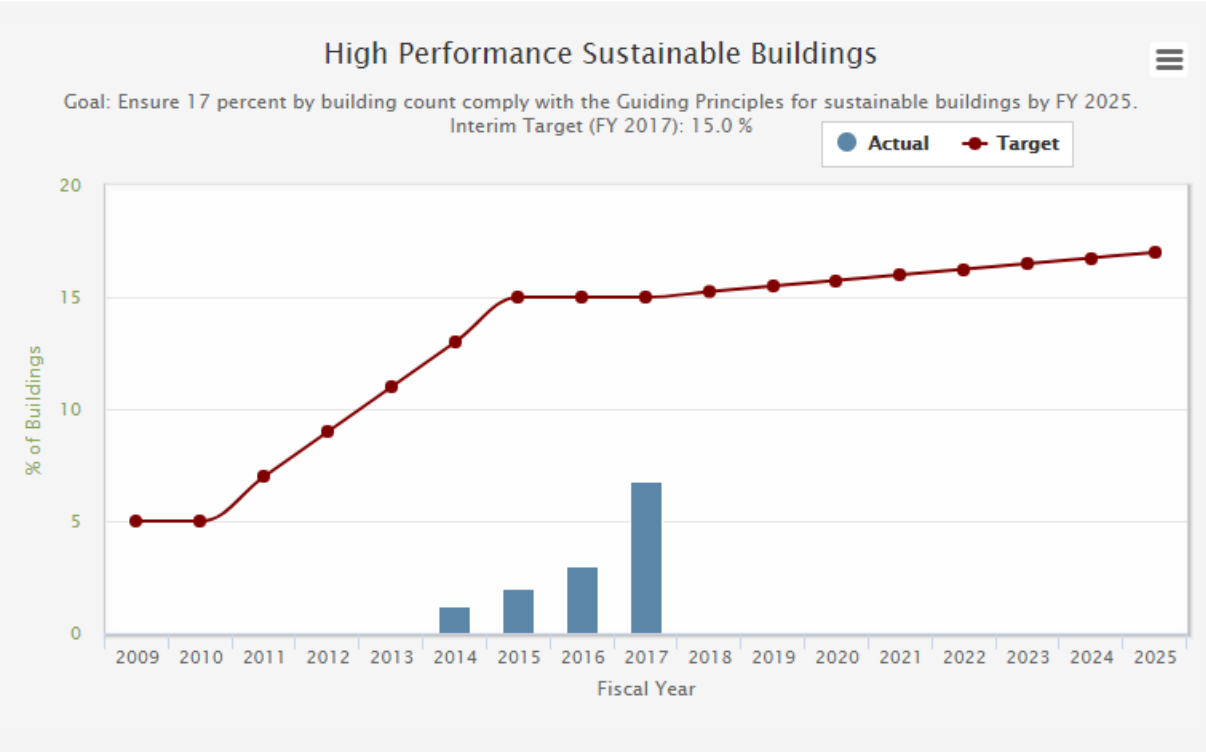
High Performance Sustainable Buildings

Goal: Ensure 17 percent by building count comply with the Guiding Principles for sustainable buildings by FY 2025. Interim Target (FY 2017): 15.0 %

Current Performance: 6.8%

	Building Count	GSF
Guiding Principles Certified	7	127,621
Total Applicable*	103	2,069,407
Performance (%)	**6.80%**	**6.17%**

* Applicable means buildings and trailers that are DOE owned or DOE leased where the gross/rentable SqFt is greater than 5,000.



2025 Goal: 1% of buildings water, waste, or energy net-zero | 2017 Actual: 0%

2020 Goal: All buildings entering the planning process designed to achieve energy net-zero | 2017 Actual: 0%

In FY 2017, four buildings (Mu2e, SBN-Near, SBN-Far and MC1) were added to Fermilab's inventory of buildings that meet High Performance Sustainable Building (HPSB) Guiding Principles (GPs). This brings the total Fermilab HPSB inventory count to seven out of total of 103. Of the four new buildings, three were new construction completed this year, and each was designed to meet and exceed the ASHRAE 90.1 baseline in accordance with the 10 CFR 433 performance calculation.

A procedure was updated in FY 2017 within the engineering group to ensure all new applicable construction projects will comply with HPSB GPs for new buildings. An implementation plan checklist is used to ensure that all elements of the HPSB GPs will be completed at appropriate conceptual and design stages of the projects. The Fermilab construction contract document includes Division 1 specifications which cover construction-related HPSB elements (such as indoor air quality during construction, commissioning, and construction waste management and recycling).

In addition, Fermilab's Architect/Engineer design guide provides guidance on mechanical-related elements to ensure that new applicable building projects will implement building energy modeling during the preliminary stage of the project with the goal of achieving 30% better than the ASHRAE 90.1 baseline in accordance with 10CFR433 performance calculation.

Fermilab's Campus Master Plan seeks to consolidate and combine Laboratory operations and functions into a vibrant interconnected facility. This 20-year transformative plan for Fermilab specifically includes HPSB GPs which address sustainable and climate resilient design, environmental stewardship and greater accessibility to pedestrians and cyclists.

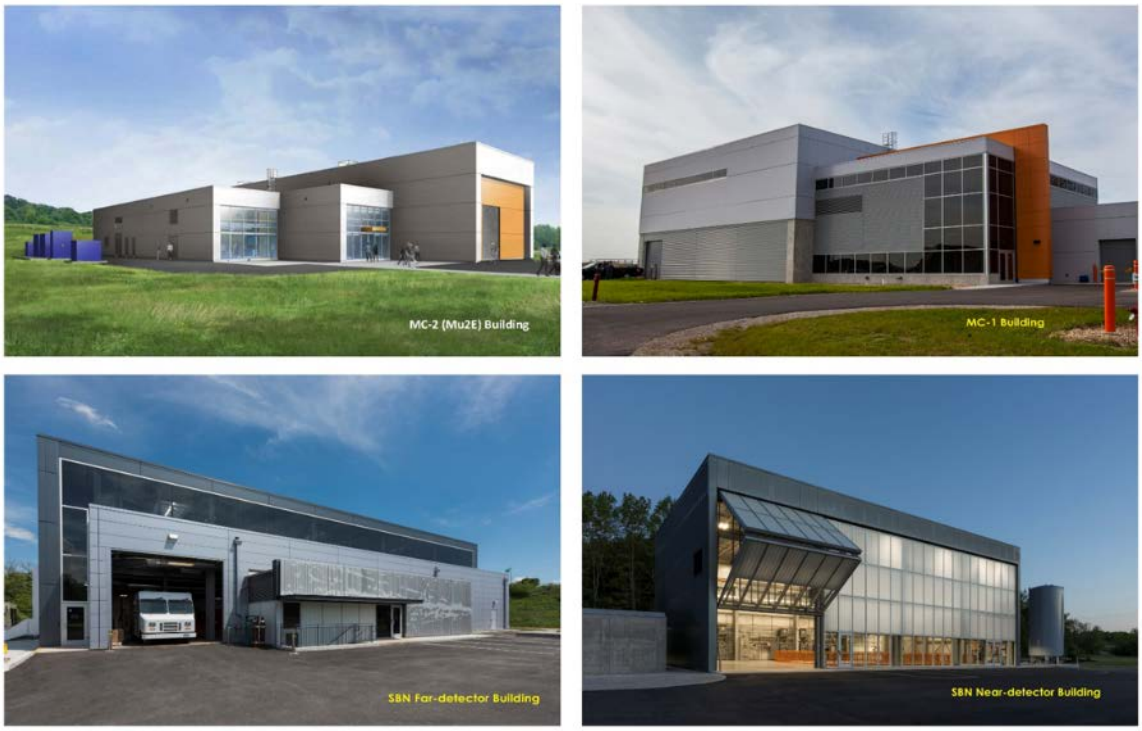
In FY 2017 there were no existing buildings or planned new construction identified to achieve net-zero energy, water, or waste.

Plans and Projected Performance

Fermilab's next new construction facility, the Industrial Center Building- Addition (ICB-A) is currently 90% through design and is expected to be 30% better than the ASHRAE 90.1 2013 baseline. In FY 2018 the ICB-A is expected to meet the new 2016 HPSB Guiding Principles for new buildings Guiding Principles. Buildings in conceptual or preliminary stages (such as PIP2, IERC and LBNF) will continue to be assessed in FY 2018 for compliance with the 2016 version of the HPSB Guiding Principles for new buildings. These projects are committed to follow and achieve HPSB GPs.

The Fermilab Campus Master Plan will be re-issued in FY 2018 with an updated and enhanced focus on centralized facilities, sustainability, planning for facility retirement, utility infrastructure, and consistency in facility design. This will support future Fermilab goals for achieving sustainability in campus construction and renovations.

The Fermilab Architect/Engineer (AE) design guide will be evaluated in FY 2018 to incorporate design elements, criteria, strategies, and action paths to support the laboratory's commitment toward future net-zero energy buildings in conventional facilities. Fermilab will focus on new buildings for NZB consideration and will include a discussion of net zero building in the next (FY 2018) published Fermilab Campus Master Plan.



Photos: Fermilab High Performance Sustainable Buildings which gained designation in FY 2017

Green Buildings: Regional and Local Planning

Performance Status

Fermilab maintains an extraordinary relationship with regional and local entities. In FY 2017 Fermilab's 50th anniversary open house brought 10,000 visitors to the site. Local law enforcement, fire departments, and local officials were invited to participate in the planning process. The event provided opportunity to highlight Fermilab's commitment to sustainability. Beyond the open house, Fermilab hosted special activities throughout the year, many of which involved local, regional, and state and federal staff and elected officials.

Argonne and Fermilab entered into a collaboration seeking initiative in FY 2017. Senior management met regularly to develop and execute collaboration opportunities. Some outcomes have included joint training exercises, a mutual road salt contract, and identification of a collaboration around onsite health care.

Facilities and Engineering staff met in FY 2017 with staffs from both DuPage and Kane Counties to discuss stormwater modeling programs and future development and improvement opportunities. The City of Warrenville additionally developed a plan to carry out scoping of the portion of Fermilab's sanitary sewer system which impacts the City's system upon exiting the laboratory. Some local collaborative arrangements utilize shared geographic information system (GIS) data for mutual benefit.

Finally, Fermilab maintains an established relationship with PACE, the local public transportation provider, which facilitates the use of public transportation by Fermilab employees to/from the Geneva, IL Metra train station.

Plans and Projected Performance

Fermilab looks forward to continuing excellent relationships with local municipalities, counties, regional planning entities, elected officials and others in FY 2018 and beyond.

Acquisition & Procurement

Performance Status

Sustainable Acquisition

Goal: Ensure 95 percent of new contract actions for products and services meet sustainable acquisition requirements

Interim Target (FY 2017): 95.0 %

Current Performance: 100%

	Contracts Reviewed	Contracts Without Opportunity	Contracts Meeting All Requirements	%
Number of Contracts	286	0	286	100.0%

In FY 2017 Fermilab applied sustainable acquisition requirements to procurement policies and practices. Fermilab continues to expand the use of E-marketplace, an electronic catalog system for procurement of common use items which was launched in FY 2016 and FY 2017. Use of the system has reduced the amount of paper requisitions and allows employees to place orders from the point of need, making procurement practices streamlined and more efficient.

Plans and Projected Performance

In FY 2018 Fermilab will explore additional opportunities for sustainable acquisition improvements available via the laboratory's new E-marketplace system.

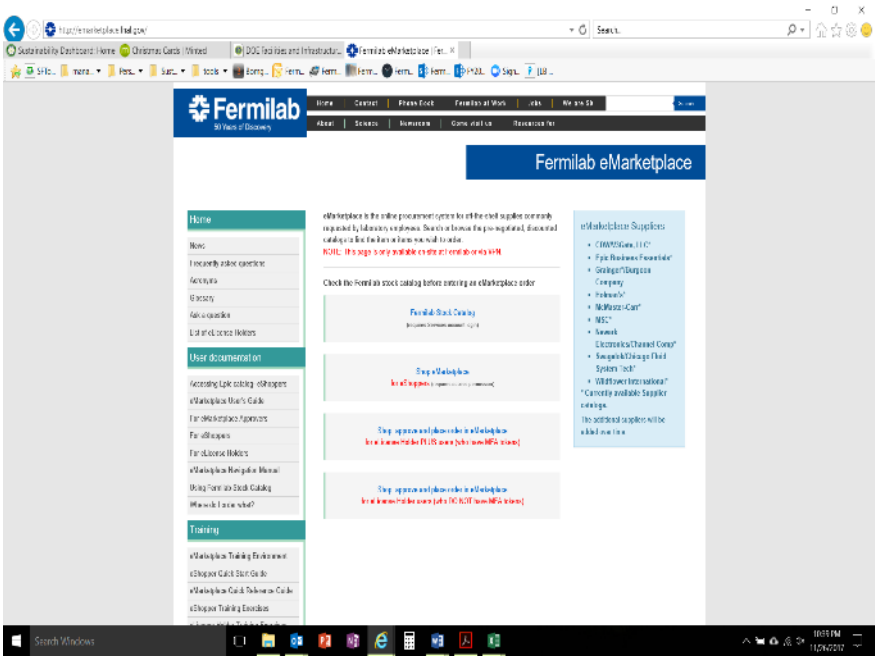


Photo: Fermilab's eMarketplace online portal

Measures, Funding, & Training

Performance Status

Over the last 16 years, Fermilab has completed 6 utility energy service contracts (UESCs, formerly called UIP) and energy savings performance contracts (ESPCs) valued at nearly $60 million. In 2014, Fermilab conducted an investment grade audit, but a viable ESPC project was not pursued.

Measurement and verification (M&V) is performed annually by Ameresco for a 15 year ESPC begun in 2011. The M&V reports verify that the projected energy savings are all being met. The ESPC included a new central plant boiler, various lighting upgrades, and disconnection of unused transformers.

Energy Conservation Measures (ECMs) were performed at 4 facilities in FY 2017. Fermilab took advantage of incentive funds available from Illinois' Smart Energy Design Assistance Center (SEDAC). In FY 2017, Fermilab received $41,400 in incentives from SEDAC for implementing the ECMs which will save 243 MWh and 731 therms annually.

Plans and Projected Performance

Fermilab will continue to assess future opportunities including technology specific measures. Recent state legislation has removed Fermilab and other high energy-consuming customers from its public energy efficiency incentive program. However, Fermilab is investigating the development of an in-house program to reinvest and incentivize energy efficiency projects.

In FY 2018 Fermilab will participate in the DOE Facilities and Infrastructure Restoration and Modernization Program (FIRM). The program offers an assessment of the potential for conducting "deep energy efficiency retrofits" on a campus and an analysis of the potential for using financing mechanisms (UESC, ESPC, etc.) to complete the work. The National Renewable Energy Laboratory (NREL) will visit Fermilab to begin the assessment in first quarter FY 2018.

Travel & Commute

Performance Status

2025 Goal: 25% Scope 3 GHG reduction from FY 2008 baseline | FY 2017 Goal: 9% reduction | FY 2017 Actual: 69% reduction

The majority of the approximately 1,900 Fermilab employees commute to work by automobile an average distance of 14 miles. Fermilab GHG emissions due to employee commuting remain constant at approximately 4,285 MT CO_2e.

In FY 2017 Fermilab installed two new electrical charging stations to support fleet electrical vehicles. The charging stations were made available to employees for personal vehicle charging on fee-based, per charge system. Payment for energy used is via a third-party vendor. See Fleet Management for more information.

Fermilab's leadership position in the global high-energy physics community dictates that employees and visitors travel, and often the travel involves international trips. In 2017, employee airline trips totaled approximately 13.75 million miles and accounted for 2,533 MT CO_2e. This slightly exceeds 2008 baseline data of 2,215 MT CO_2e. Recent travel increases are reflective of trip increases related to the planned Deep Underground Neutrino Experiment (DUNE) experiment to be located at the Sanford Underground Research Facility in Lead, South Dakota.

To reduce business travel, Fermilab continues to use 38 fully equipped conference rooms to accommodate video-conferencing. Seminars and training sessions are conducted via web-based meeting software and/or tele- and video-conferencing technology. The Compact Muon Solenoid (CMS) control room located prominently adjacent to Wilson Hall's main atrium remotely operates the CMS experiment at the Large Hadron Collider in Geneva, Switzerland. This capability makes many trips to Geneva unnecessary and thereby avoids significant GHG emissions from air travel. Another remote operations control room (ROC West) is used continuously for operating domestic experiments that are significant distances from Fermilab.

Fermilab has an active commuter bicycling group, some of whom track their mileage to and from work. Riders maintain an interactive website and they log their commuter mileage. In an average year over 20,000 person-miles are logged commuting to and from work. Additionally, the Fermilab campus supports a network of bike trails and bike lanes that encourage this mode of alternative transportation. In 2017 Fermilab pursued a new on-site bike share program using a bike share vendor. The program will be of limited scale and augment another bike share program currently managed by the laboratory to support visiting researchers in residence on the site.

Beginning in 2015, Fermilab employees have had an option to participate in modified work schedules through a Flexible Work Policy. The policy defines and establishes guidelines for voluntary flexible work schedules. Flexible hours authorize employees with their supervisor's approval to vary their work schedules. The flexible work policy and telecommuting both reduce the number of employee commuting trips to the laboratory. Fermilab's time keeping system allows for employees to make note of their participation in the program.

Photo: Fermilab Bicycle Commuters

Plans and Projected Performance

In FY 2018 Fermilab will continue to evaluate the electric vehicle charging stations' use to maximize commuter access to the stations. Fermilab will also evaluate the new bikeshare program for use, to optimize the number of onsite and offsite trips taken by employee users of the program. Fermilab is also investigating bringing a car sharing service to site for short-distance driving trips.

Air travel is likely to increase in out years due to travel to Lead, South Dakota where the LBNF-DUNE site is being constructed and project team members travel to visit with international project partners.

Photo: Groundbreaking underground for the International Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment, South Dakota Detector Hall

Fugitives & Refrigerants

Performance Status

2025 Goal: Reduce Scope 1 & 2 GHG emissions by 50% from FY 2008 baseline | FY 2017 Goal: 25% reduction | FY 2017 Actual: 62% reduction

In FY 2017, Fermilab's Scope 1 & 2 greenhouse gas emissions remain at historic lows. The second largest contribution to Scope 1 & 2 emissions was from fugitive emissions related to refrigerant management. However, the fugitive emissions contribution dropped significantly from FY 2016 to FY 2017, and is expected to continue to drop after an internal review of refrigerant management policies and procedures in FY 2017.

Fugitive emissions occur in several locations and may be associated with once through gas systems related to experiment apparatus. A significant contributor to fugitive emissions in the past was sulfur hexafluoride (SF_6), however current inventories are limited to small amounts and are managed using a Dilo recovery system.

Photo: Fermilab's Dilo SF_6 Recovery Cart

Plans and Projected Performance

As a result of the refrigerant management review in FY 2017, Fermilab will improve its tracking and management of refrigerants in FY 2018 which should lead to a continued decline in fugitive emissions. Fermilab will continue to monitor and manage fugitive emissions to reduce current levels by the maximum extent practicable.

Electronic Stewardship

Performance Status

Electronics Acquisition

Goal: 100 percent of eligible electronics procurements must be environmentally sustainable (e.g. EPEAT)

Interim Target (FY 2017): 95.0 %

Current Performance: 96%

	EPEAT Acquired	Total Acquired	%
Monitors	245	273	89.7%
Computers	564	550	102.5%
Imaging Equipment	2	2	100.0%
Televisions	10	33	30.3%
Total Acquired	**821**	**858**	**95.7%**

Power Management

Goal: Implement and actively use power management features on 100 percent of eligible computers (PCs & laptops) and monitors

Interim Target (FY 2017): 100.0 %

Current Performance: 96%

	Total Owned	PM Enabled	Exempt	%
Monitors	0	0	0	N/A
Computers	5,366	3,829	1,369	95.8%
Total Items	**5,366**	**3,829**	**1,369**	**95.8%**

Duplex Printing

Goal: Implement and actively use duplex printing features of 100 percent of eligible printers

Interim Target (FY 2017): 100.0 %

Current Performance: 100%

	Total Owned	Duplex Enabled	Incapable	%
Total Printers	**301**	**298**	**3**	**100.0%**

Electronics Recycling

Goal: Dispose of 100 percent of electronics through government programs and certified recyclers

Interim Target (FY 2017): 100.0 %

Current Performance: 100%

	Amount	%
Transferred or Donated	1.273	2.6%
Recycled by Certified Recycler	48.347	97.4%
Recycled by non-Certified Recycler	0.000	0.0%
Amount disposed (e.g. landfill)	0.000	0.0%
Total Electronics Waste (metric tons)	**49.620**	**100.0%**

Fermilab is an excellent steward of its electronic resources. In FY 2017, Fermilab awarded the Energy Star designation for the Grid Computing Center for a seventh consecutive year.

In FY 2017 in the new mobile phone category, 51 Gold and 3 Silver EPEAT mobile phones were purchased out of a total of 78 (24 had unknown EPEAT certification status).

The Lattice Computing Center was retired in December 2016 and the 2842 square feet was re-purposed. Since 2011, the total computer room space consolidated is nearly 11,000 sq. ft.

Fermilab's Scientific Computing Division High Energy Physics (HEP) Cloud project has demonstrated the ability to burst into commercial and High-Performance Computing (HPC) resources at a level of 25% of global Content Management System (CMS) resources and multiple factors above local Intensity Frontier experiment resources. This year's effort has focused on expanding HEP Cloud to utilize HPC facilities at the National Energy Research Scientific Computing Center (NERSC) and the Argonne Leadership Computing Facility (ALCF) to optimally use overall DOE resources. Fermilab has also added Mu2e as a user of the HPC machines.

Photo: Fermilab Grid Computing Center's Energy Star Certificate, 2017

Plans and Projected Performance

In FY 2018 Fermilab's data center efficiency is expected to improve based on the following projected activities. First, the power usage effectiveness (PUE) of the Feynman Computing Center is expected to drop below 1.5 in the next year resulting from a cooling upgrade and uninterruptible power supply (UPS) retirement. Second, the savings estimate for migrating workloads from single purpose physical systems to virtual machines is more than $2.2M or about 80% over approximately 6 years.

Photo: Computer Room at Feynman Computing Center

Organizational Resilience

Performance Status

Goal	Initiated	Complete
Update policies to incentivize planning for, and addressing the impacts of extreme events due to changes in weather patterns.	Yes	No
Update emergency response procedures and protocols to account for projected change, including extreme weather events.	Yes	No
Ensure workforce protocols and policies reflect projected human health and safety impacts.	No	No
Ensure site/lab management demonstrate commitment to adaptation efforts through internal communications and policies.	Yes	No
Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current science, updated as necessary.	Yes	No

In FY 2017 Fermilab completed a climate change vulnerabilities screening. Eleven separate asset types associated with laboratory operations were evaluated for the potential of risk. The resulting risk ranking identified asset types that may be at risk. The risks showing the highest ranking were assets associated with the laboratory's industrial cooling water system, the electrical distribution system and some aspects of accelerator research equipment.

Fermilab improved operational resilience in FY 2017 through investments in a utilities upgrade project (UUP). Improvements resulting from the UUP include a significant replacement of backbone piping associated with the laboratory's industrial cooling water system, improved interconnection of certain portions of the cooling water piping and pond system to enhance water recapture, upgrades to a water supply well used to provide make-up cooling water, and the replacement of the master electrical power substation. Additionally, under Fermilab's Surface Water Management Plan, improvements were made to storm water containment and collection in the Village to better manage extreme rain storm events.

Photo: Staging of Installation of Industrial Cooling Water Pipe for the Fermilab Utilities Upgrade Project

Plans and Projected Performance

In FY 2018 Fermilab will evaluate the risk rank output from the screening tool. Results from the screening highlight assets types that may be pursued for further investigation.

The laboratory is developing a storm water culvert repair plan to mitigate the impact of flooding events across the site. Also planned is a major renovation of a parking lot serving Fermilab's main building (Wilson Hall) that has had chronic flooding problems during large rain events. A significant change will be made to the drainage system to alleviate the flooding. Finally, in FY 2018 Fermilab is projected to complete an addition to the Casey's Pond ICW pumphouse, relocating all critical electrical switchgear to the addition which is elevated above the floodplain.

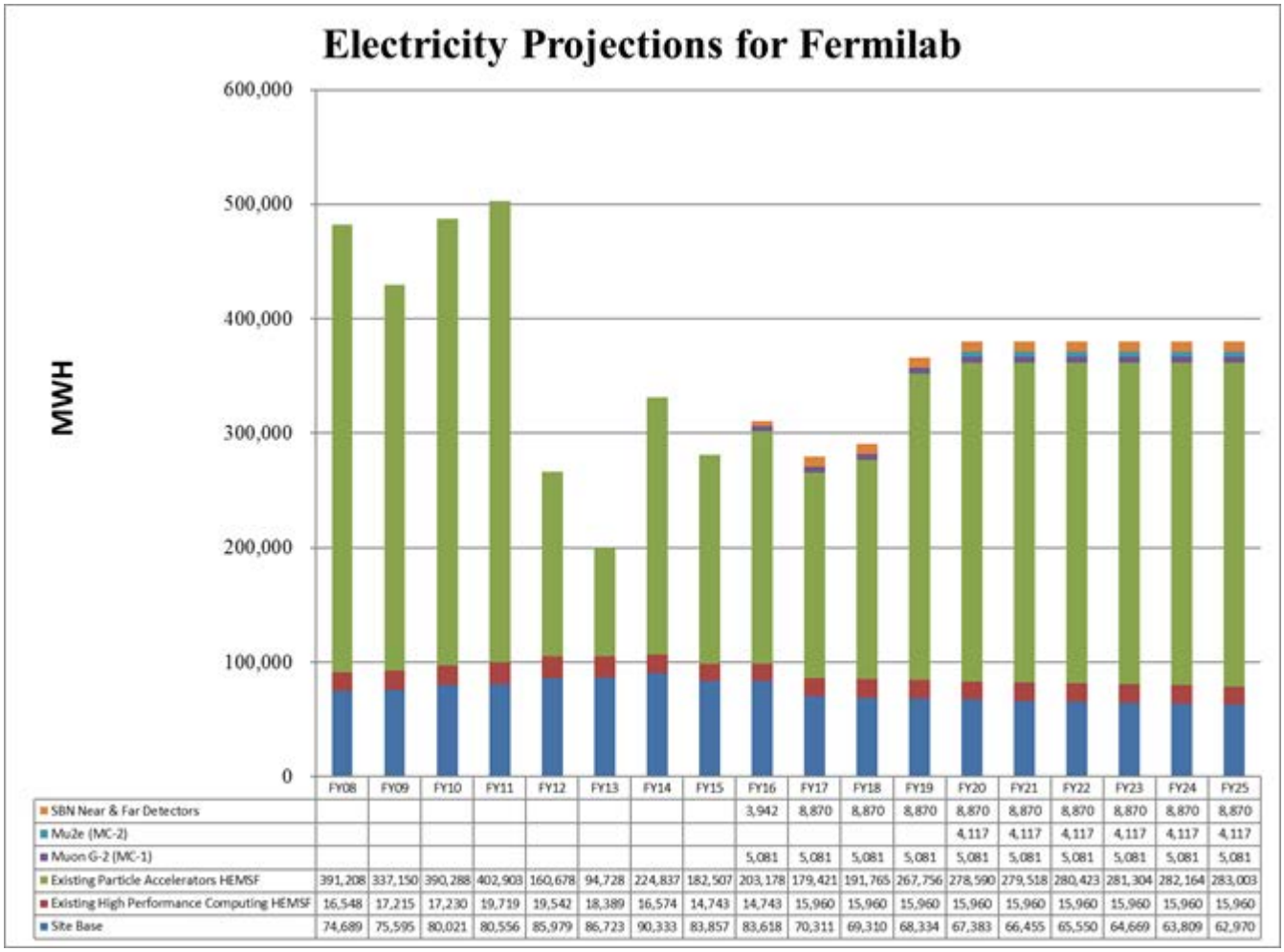
SC Supplemental

SC Supplemental: Energy Management

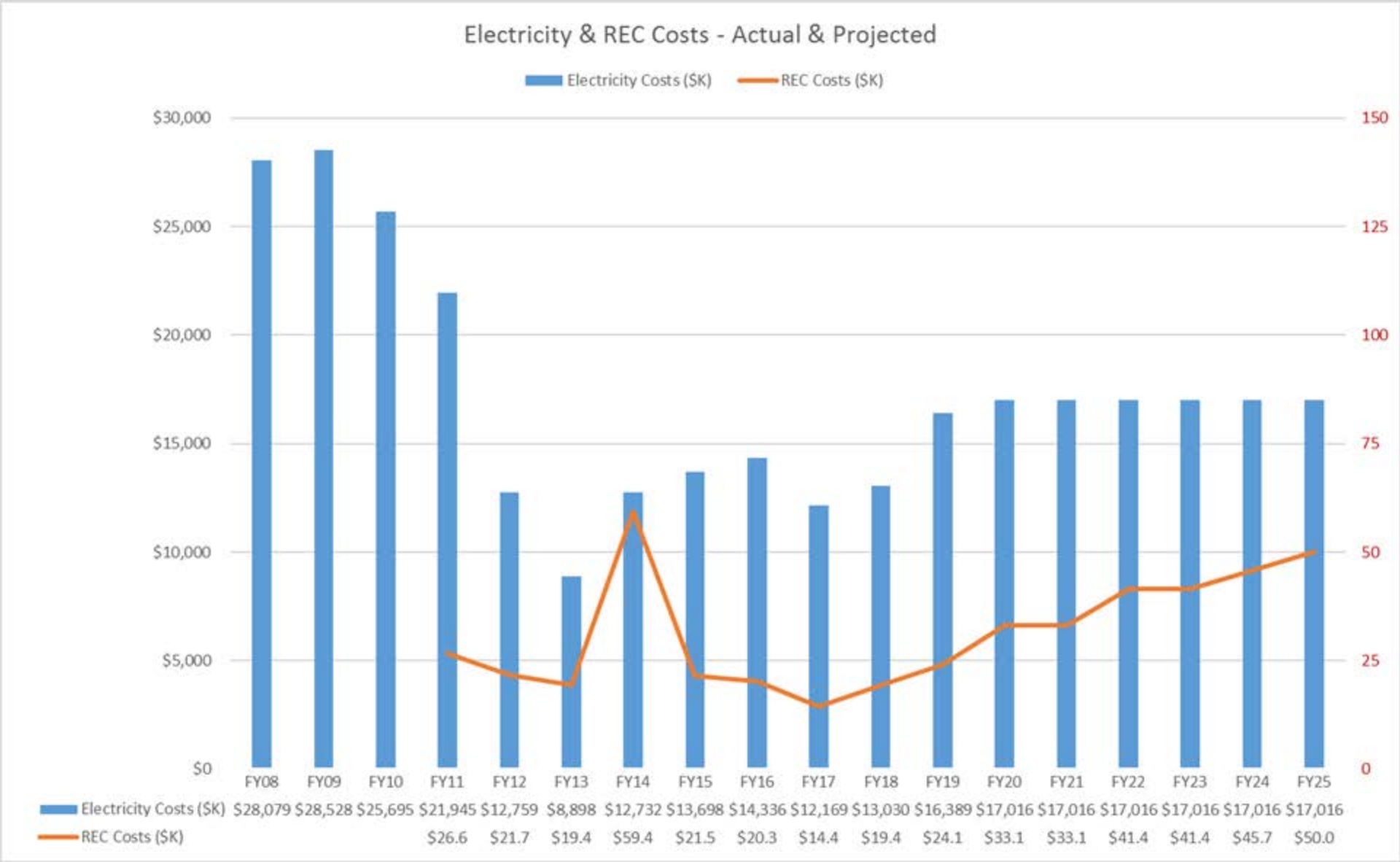
Performance Status

Fermilab has no goal-subject buildings over 5,000 gsf with EUI over 150 BTU/GSF.

Plans and Projected Performance



	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25
SBN Near & Far Detectors									3,942	8,870	8,870	8,870	8,870	8,870	8,870	8,870	8,870	8,870
Mu2e (MC-2)													4,117	4,117	4,117	4,117	4,117	4,117
Muon G-2 (MC-1)									5,081	5,081	5,081	5,081	5,081	5,081	5,081	5,081	5,081	5,081
Existing Particle Accelerators HEMSF	391,208	337,150	390,288	402,903	160,678	94,728	224,837	182,507	203,178	179,421	191,765	267,756	278,590	279,518	280,423	281,304	282,164	283,003
Existing High Performance Computing HEMSF	16,548	17,215	17,230	19,719	19,542	18,389	16,574	14,743	14,743	15,960	15,960	15,960	15,960	15,960	15,960	15,960	15,960	15,960
Site Base	74,689	75,595	80,021	80,556	85,979	86,723	90,333	83,857	83,618	70,311	69,310	68,334	67,383	66,455	65,550	64,669	63,809	62,970


Electricity & REC Costs - Actual & Projected
Electricity Costs ($K)
REC Costs ($K)
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
150
125
100
75
50
25
0
FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19 FY20 FY21 FY22 FY23 FY24 FY25
Electricity Costs ($K) $28,079 $28,528 $25,695 $21,945 $12,759 $8,898 $12,732 $13,698 $14,336 $12,169 $13,030 $16,389 $17,016 $17,016 $17,016 $17,016 $17,016 $17,016
REC Costs ($K) $26.6 $21.7 $19.4 $59.4 $21.5 $20.3 $14.4 $19.4 $24.1 $33.1 $33.1 $41.4 $41.4 $45.7 $50.0

SC Supplemental: Water Management

Performance Status

Potable Water Intensity Use, Potable Water Use

Fermilab has limited domestic water meters at the building level. Wilson Hall and new construction facilities are metered at the building level. However, only Wilson Hall and the Illinois Accelerator Research Center (OTE) are both metered for domestic water and populated with Fermilab staff in regularly occupied office settings.

FY17 Potable Water Intensity Use			
Facility	**kGal**	**gsf**	**UI (Gal/gsf)**
CMTF	218	27,204	8.00
HAB	27	41,610	0.65
MC-1	551	14,881	37.03
OTE	342	47,300	7.22
Wilson Hall	2,912	420,213	6.93
Total	4,049	551,208	7.35

Plans and Projected Performance

In FY 2018 and FY 2019, Fermilab will produce a Utility Infrastructure Plan. The Plan will prioritize and schedule the deployment of utility infrastructure meters such as domestic water. The Laboratory will add domestic water meters in support of the Utility Infrastructure Plan as able.

SC Supplemental: Fugitives and Refrigerants

Performance Status

Fermilab's SF_6 emissions were under 500 lbs in both FY 2016 and FY 2017.

Plans and Projected Performance

Fermilab's SF_6 emissions are anticipated to be under 500 lbs in FY 2018 and beyond.

SC Supplemental: Measures, Funding and Training

Performance Status

Summary of Sustainability Funding (K$)			
	FY17 Actual	**FY18 Planned/Request**	**FY19 Projected**
Category			
Sustainability Projects	0.0	0.0	0.0
Sustainability Activities other than projects	0.0	0.0	0.0
SPO Funded Projects (SPO funding portion only)	0.0	0.0	0.0
Site Contribution to SPO Funded Project	0.0	0.0	0.0
ESPC/UESC Contract Payments	188.5	196.6	206.3
Renewable Energy Credits (REC) Purchase Costs	14.4	19.4	24.1
Total	202.9	216.0	230.4