# Fermilab

## 2021 Site Sustainability Plan

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# Executive Summary

Fermi National Accelerator Laboratory is an international hub for particle physics. Fermilab's employees and 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. The strategy's primary ten-year focus is a world-leading neutrino science program anchored by the Long Baseline Neutrino Facility (LBNF) and Deep Underground Neutrino Experiment (DUNE).

Fermilab's 6,800-acre site and extensive infrastructure supports the laboratory's particle physics research program, including the experiments at the Fermilab Accelerator Complex user facility and others located around the world. The laboratory's infrastructure is being primed for significant change to support the requirements of the international LBNF/DUNE and PIP-II projects. LBNF and DUNE will be powered by megawatt beams from an upgraded and modernized accelerator complex made possible by the Proton Improvement Plan II (PIP-II). The flagship facility comprised of LBNF, DUNE, and PIP-II will be the first international mega-science project based at a Department of Energy national laboratory.

The operation of Fermilab was different in 2020 than from any other in its 53-year history as a result of the novel COVID-19 pandemic crisis. Beginning in early March, measures were taken to help control the spread of the virus by drastically reducing staff on site for work. Most of the laboratory's workforce was quickly transitioned to remote work by maximizing telecommuting opportunities, with only essential staff initially permitted on site to maintain the operation of key accelerator systems and to ensure security of the facility. As restrictions eased in subsequent months, a phased return to onsite work plan was implemented balancing both risk and mission need. The impacts to site operations were significant and these are reflected in Fermilab's FY2020 sustainability metrics.

The laboratory consumed just 66% of anticipated electricity in FY2020. The near complete closure of the facility in late winter forced a suspension of experimental physics as the pandemic unfolded. Fermilab adjusted by using the opportunity to begin on site preparation work for LBNF earlier than planned, providing the project an early springtime start to civil construction ahead of schedule.

Fermilab's vehicle fleet consumed 15,000 gallons less fuel than the previous year due to dramatically reduced transportation needs across the site. Similarly, as working remotely became the new norm for virtually all staff, telework employees drove 5.28 million fewer miles commuting to and from work. This is the lowest recorded commuter mileage since Fermilab has tracked this metric. The reduction in travel produced an associated decrease in greenhouse gas tailpipe emissions of 35 %. Emissions associated with business airline travel similarly decreased due to pandemic restrictions, with laboratory staff flying 8.2 million fewer miles in 2020. Greatly reduced staff on site produced significantly less waste, generating 40% less municipal waste from the previous year.

Greenhouse gas emissions associated with operations in FY2020 were correspondingly at very low levels, with Scope 1 and 2 emissions showing a 72 % reduction from the recorded 2008 baseline, and Scope 3 emissions 78% below baseline.

Overall potable (drinking) water use was higher than Fermilab's 5-year consumption average and likely due to three large and persistent below ground leaks in the water distribution system. The leaks were repaired, however dramatically reduced on site staff added to the challenge of leak discovery.

Fermilab expects that as the novel Coronavirus pandemic is mitigated in 2021 and with emerging vaccines, the laboratory will resume some level of previous onsite staffing presence. It is expected that Fermilab would see therefore a related bounce in the previously mentioned metrics. However, the laboratory is engaging in a "Future of Work" planning process to identify a new level of regular, sustained telecommuting practice and other post-pandemic working conditions. Some of those lasting changes may yield longer term, sustained reductions in commuting emissions, water consumption, waste production, and other sustainability metrics.

## Mission Changes

Fermilab's organization and infrastructure continue to evolve primarily in support of hosting the international Long Baseline Neutrino Facility (LBNF) and the Deep Underground Neutrino Experiment (DUNE). By extension, the ongoing build-out of the Proton Improvement Plan-II (PIP-II) accelerator at Fermilab is a top priority for the laboratory. The multi-year pivot towards this new experiment requires modernized, state-of-the-art onsite infrastructure to support anticipated scientific opportunities for discovery. Upgrades to the accelerator complex enabled by the PIP-II project will provide megawatts of beam power to LBNF/DUNE. These upgrades will yield a significant increase in the amount of energy consumed by the laboratory.

In addition to modernized facilities and infrastructure at Fermilab in support of LBNF/DUNE/PIP-II, the Department of Energy has a real-property lease with the South Dakota Science and Technology Authority (SDSTA) at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. Significant real-property improvements have commenced at SURF in both leased space and non-leased space in support of the DOE science mission.

Fermilab has recently been selected to lead a national center for advancing quantum science and technology. The planned new Superconducting Quantum Materials and Systems Center (SQMS) at Fermilab will work towards the development and deployment of a beyond-state-of-the-art quantum computer based on superconducting technologies. The center also will develop new quantum sensors, which could lead to the discovery of the nature of dark matter and other elusive subatomic particles. The revolutionary leaps in quantum computing and sensing that the center aims for will be enabled by a unique multidisciplinary collaboration that includes 20 partner organizations consisting of other national laboratories, academic institutions and industry.


*Groundbreaking ceremony this past summer for the PIP-II cryogenic plant*

# Energy Management

**Performance Status**

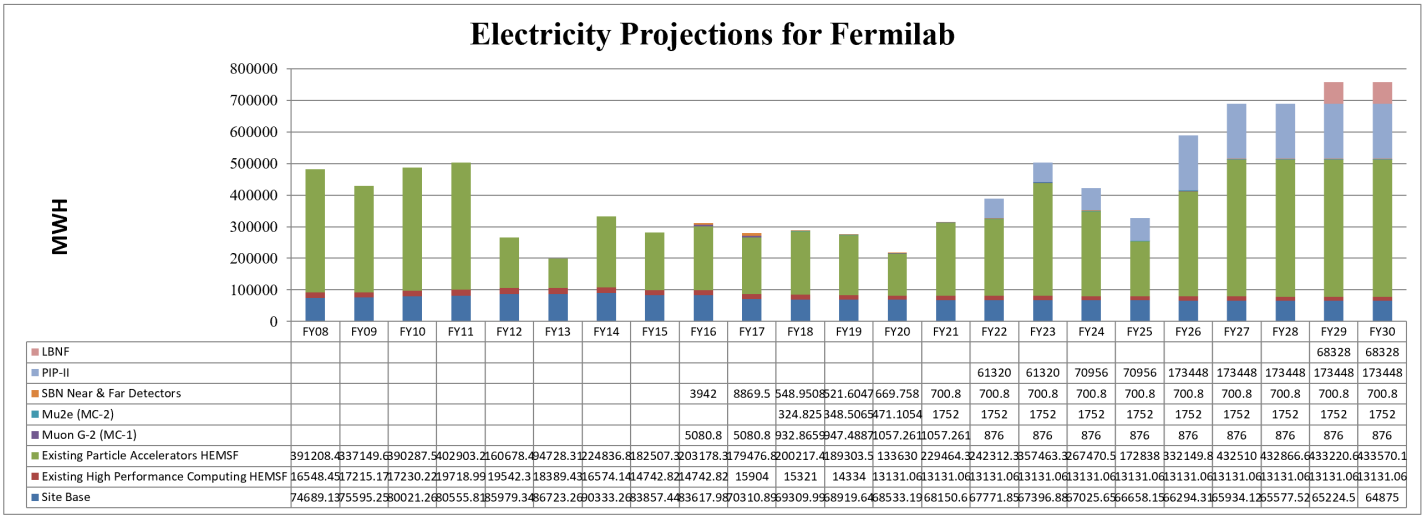
Fermilab's electrical energy consumption was 66.6% of anticipated use in FY2020. Most of the reduction was due to powering down the accelerator as the laboratory drastically reduced operations in mid-March in response to the COVID-19 pandemic. An accelerator maintenance shutdown originally planned to begin early June was begun 2 months early. The laboratory used this opportunity to begin site preparation work sooner than originally planned for civil construction work associated with the LBNF project. In addition, many HVAC systems in buildings used to support employees were placed in the unoccupied mode to conserve resources during curtailed operations.

The reduction in electrical energy demand resulted in a decreased real-time electricity cost of 82.7% from previously forecasted use. Fermilab uses a strategy to procure and secure electricity in megawatt blocks using dollar cost averaging over a one to three-year period. Because of the drastic change to operations and early shutdown of the accelerator, the extra blocks could not be sold in advance. A vastly depressed regional energy market in April and May resulted in Fermilab selling power blocks purchased at pre-pandemic rates on the spot market at a net loss.

Participating in electrical power curtailment exercises that are encouraged by Fermilab's regional transmission organization, PMJ, provide several benefits to the laboratory. In 2020, the laboratory participated in a summer energy curtailment program as negotiated with the laboratory's curtailment service provider. The demand reduction exercise yielded compensation of $180K as Fermilab met the target demand reduction goal of 2.9 MW. In addition to the financial advantage, participating in demand curtailment programs provide advanced warning to Fermilab in the event of electrical distribution disruptions from the electrical grid. This permits decisions to be made to protect equipment sensitive to electrical disruptions prior an occurrence. PJM has developed a new winter curtailment program that Fermilab will participate in for first time. The winter curtailment exercise has the potential for an additional $20K in compensation if demand reduction goals are met. Future participation in this program will be determined after evaluating the results of this winter's curtailment.

**Plans and Projected Performance**

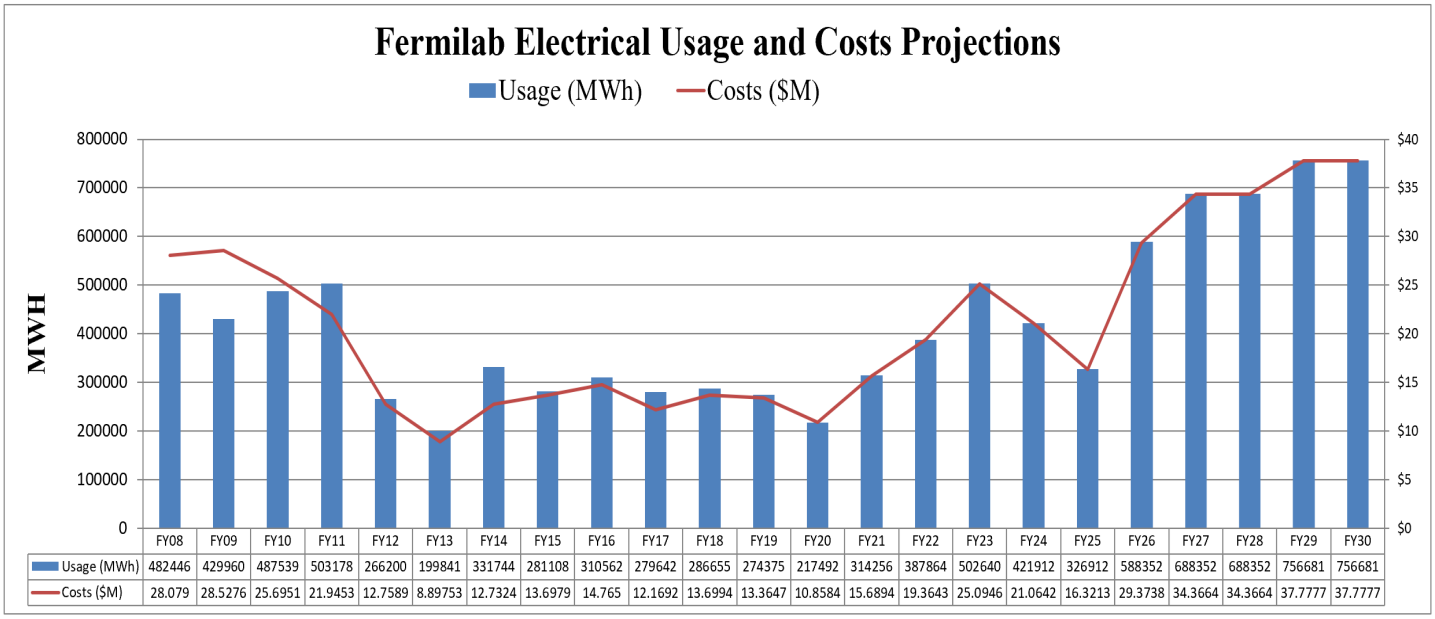
*Electricity Use Projections*



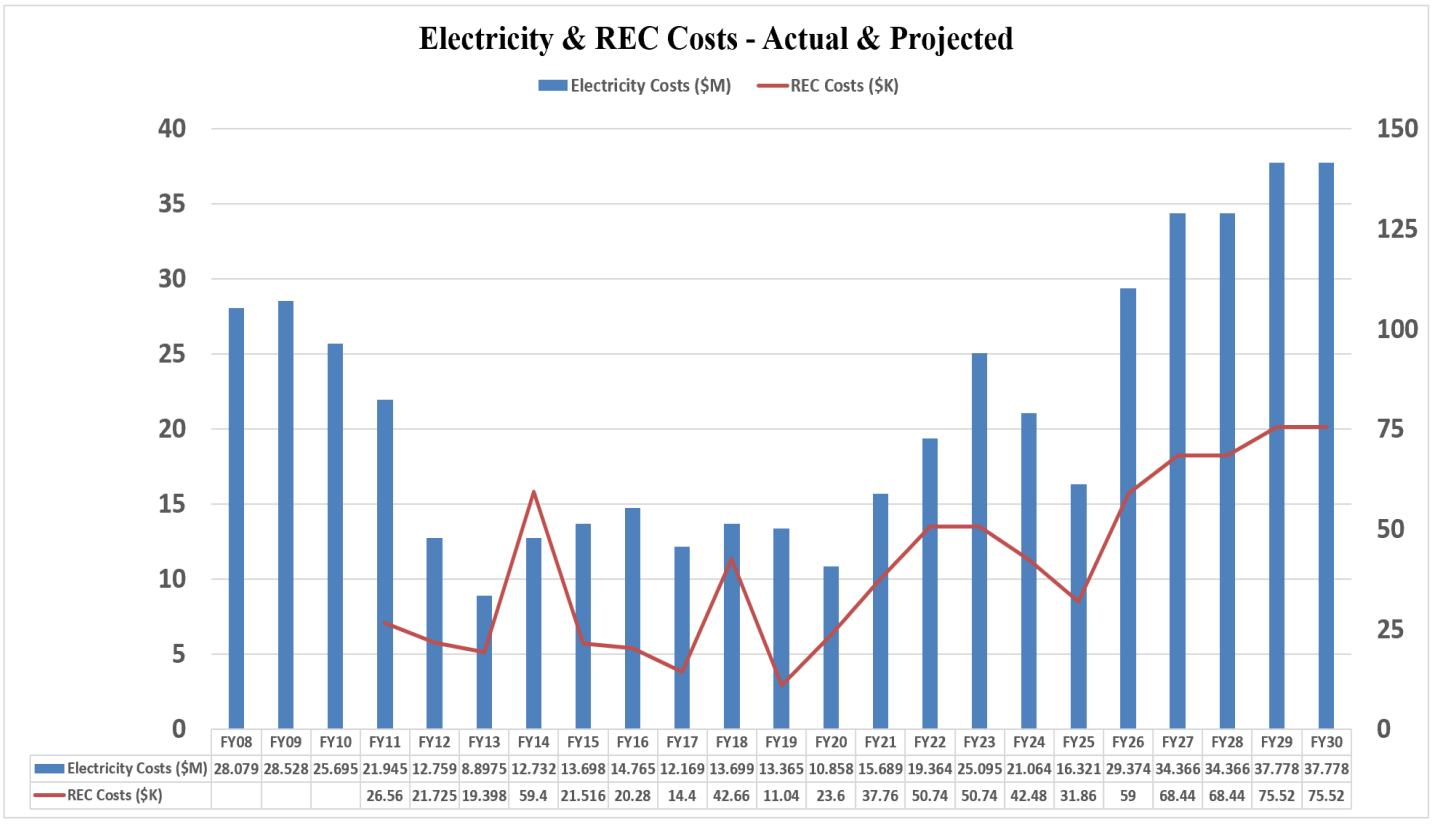

| | FY08 | FY09 | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 | FY21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBNF | | | | | | | | | | | | | | | | | | | | | | 68328 | 68328 |
| PIP-II | | | | | | | | | | | | | | | 61320 | 61320 | 70956 | 70956 | 173448 | 173448 | 173448 | 173448 | 173448 |
| SBN Near & Far Detectors | | | | | | | | | 3942 | 8869.5 | 548.9508 | 521.6047 | 669.758 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 | 700.8 |
| Mu2e (MC-2) | | | | | | | | | | | 324.825 | 348.5065 | 471.1054 | 1752 | 1752 | 1752 | 1752 | 1752 | 1752 | 1752 | 1752 | 1752 | 1752 |
| Muon G-2 (MC-1) | | | | | | | | | 5080.8 | 5080.8 | 932.8659 | 947.4887 | 1057.261 | 1057.261 | 876 | 876 | 876 | 876 | 876 | 876 | 876 | 876 | 876 |
| Existing Particle Accelerators HEMSF | 391208.4 | 337149.6 | 390287.5 | 402903.2 | 160678.4 | 94728.31 | 224836.8 | 182507.3 | 203178.3 | 179476.8 | 200217.4 | 189303.5 | 133630 | 229464.3 | 242312.3 | 357463.3 | 267470.5 | 172838 | 332149.8 | 432510 | 432866.6 | 433220.6 | 433570.1 |
| Existing High Performance Computing HEMSF | 16548.45 | 17215.17 | 17230.22 | 19718.99 | 19542.3 | 18389.43 | 16574.14 | 14742.82 | 14742.82 | 15904 | 15321 | 14334 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 | 13131.06 |
| Site Base | 74689.13 | 75595.25 | 80021.26 | 80555.81 | 85979.34 | 86723.26 | 90333.26 | 83857.44 | 83617.98 | 70310.89 | 69309.99 | 68919.64 | 68533.19 | 68150.66 | 67771.85 | 67396.88 | 67025.65 | 66658.15 | 66294.31 | 65934.12 | 65577.52 | 65224.5 | 64875 |

Significant changes to Fermilab's projected energy consumption are anticipated beginning 2024, when a planned 2-year accelerator shutdown begins to bring the new PIP-II accelerator complex online. During the

shutdown, Long Baseline Neutrino Facility infrastructure will tie into the existing accelerator complex. The addition of the PIP-II accelerator and beam requirements for LBNF are expected to increase Fermilab's overall energy consumption by 30% over historic peak levels.




| | FY08 | FY09 | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 | FY21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Usage (MWh) | 482446 | 429960 | 487539 | 503178 | 266200 | 199841 | 331744 | 281108 | 310562 | 279642 | 286655 | 274375 | 217492 | 314256 | 387864 | 502640 | 421912 | 326912 | 588352 | 688352 | 688352 | 756681 | 756681 |
| Costs ($M) | 28.079 | 28.5276 | 25.6951 | 21.9453 | 12.7589 | 8.89753 | 12.7324 | 13.6979 | 14.765 | 12.1692 | 13.6994 | 13.3647 | 10.8584 | 15.6894 | 19.3643 | 25.0946 | 21.0642 | 16.3213 | 29.3738 | 34.3664 | 34.3664 | 37.7777 | 37.7777 |




| | FY08 | FY09 | FY10 | FY11 | FY12 | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 | FY21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity Costs ($M) | 28.079 | 28.528 | 25.695 | 21.945 | 12.759 | 8.8975 | 12.732 | 13.698 | 14.765 | 12.169 | 13.699 | 13.365 | 10.858 | 15.689 | 19.364 | 25.095 | 21.064 | 16.321 | 29.374 | 34.366 | 34.366 | 37.778 | 37.778 |
| REC Costs ($K) | | | | 26.56 | 21.725 | 19.398 | 59.4 | 21.516 | 20.28 | 14.4 | 42.66 | 11.04 | 23.6 | 37.76 | 50.74 | 50.74 | 42.48 | 31.86 | 59 | 68.44 | 68.44 | 75.52 | 75.52 |

### *Scope 1 & 2 Greenhouse Gas Reduction*

**Performance Status**

Scope 1 & 2 greenhouse gas emissions are at historic lows for reasons stated above and elsewhere in this plan. The primary reason for current GHG reductions is attributable to less electrical power consumption at the laboratory. Electrical power needs are expected to increase as upgraded accelerator facilities are brought online and beam power requirements for Fermilab's flagship experiment at LBNF commence.

**Scope 1 & 2 Greenhouse Gas Emissions**
Goal: YOY scope 1 & 2 GHG emissions reduction from a FY 2008 baseline.
Interim Target (FY 2020): 0.0%

**Current Performance: -72.2%**

| | FY 2008 | FY 2019 (PY) | FY 2020 | % Change from Baseline | % Change from Last Year |
|---|---|---|---|---|---|
| Facility Energy | 343,366.8 | 161,122.7 | 120,825.4 | -64.8% | -25.0% |
| Non-Fleet V&E Fuel | 142.6 | 186.6 | 46.3 | -67.5% | -75.2% |
| Fleet Fuel | 691.6 | 27.9 | 0.0 | -100.0% | -100.0% |
| Fugitive Emissions | 40,165.1 | 139.1 | 708.3 | -98.2% | 409.2% |
| On-Site Landfills | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| On-Site WWT | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| Renewables | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| RECs | 0.0 | -17,435.4 | -14,619.3 | N/A | -16.2% |
| **Total (MtCO2e)** | **384,366.1** | **144,040.9** | **106,960.6** | **-72.2%** | **-25.7%** |

**Plans and Projected Performance**

Electrical load forecasts vary over the coming decade as experimental apparatus is brought online and old apparatus is decommissioned. Beginning in FY2022, the new PIP-II linear accelerator is projected to add approximately 7 MW of electrical load. Additional load increases are anticipated in 2022 and 2024, and ultimately increasing by 47 % over Fermilab's current load maximum. The LBNF project is projected to initially add 7.8 MW of electrical load in 2029 and increase to 8.3 MW in the following five years. These two large-scale projects combined will increase Fermilab's electrical load 62% over current levels. The laboratory anticipates using additional renewable energy certificates (RECs) to offset associated greenhouse gas emissions resulting from increased electric use.

### *Scope 3 Greenhouse Gas Reduction*

**Performance Status**

**Scope 3 Greenhouse Gas Emissions**
Goal: YOY scope 3 GHG emissions reduction from a FY 2008 baseline.
Interim Target (FY 2020): 0.0%

**Current Performance: -77.9%**

| | FY 2008 | FY 2019 (PY) | FY 2020 | % Change from Baseline | % Change from Last Year |
|---|---|---|---|---|---|
| T&D Losses* | 22,287.8 | 7,306.8 | 2,654.0 | -88.1% | -63.7% |
| T&D RECs Credit | 0.0 | -1,148.5 | -963.0 | N/A | -16.2% |
| Air Travel | 2,215.8 | 2,530.1 | 1,061.9 | -52.1% | -58.0% |
| Ground Travel | 168.9 | 128.5 | 78.7 | -53.4% | -38.8% |
| Commute | 4,633.3 | 5,392.5 | 3,493.0 | -24.6% | -35.2% |
| Off-Site MSW | 191.8 | 247.7 | 180.4 | -5.9% | -27.2% |
| Off-Site WWT | 4.8 | 11.0 | 10.8 | 125.0% | -1.8% |
| **Total (MtCO2e)** | **29,502.4** | **14,468.1** | **6,515.8** | **-77.9%** | **-55.0%** |

* Includes T&D losses for purchased renewable electricity

Fermilab's Scope 3 emissions are dominated by electrical transmission and distribution (T&D) losses. Reduced electrical power consumption equates to reduced T&D losses, and by association reduced GHG emissions. In FY2020, GHG emissions attributed to T&D losses were reduced by 52.9 % from 2019 levels and 77.9 % from the 2008 baseline.

Significant GHG emission reductions were also apparent related to employee commuting and business travel, resulting primarily from the laboratory's response to the pandemic. In 2020 expanded telecommuting became the norm for nearly all Fermilab employees. Business travel was similarly reduced producing historically low GHG emissions. See the Travel & Commute section for additional information.

**Plans and Projected Performance**

Fermilab has initiated a large pilot program to assess the possibility of expanding telework opportunities across most sectors of the laboratory. This long-term pilot is aimed at identifying options for transitioning to a more flexible work environment for employees and researchers. Similarly, a shift has occurred in how Fermilab staff and researchers interact with peers and colleagues from other institutions. The dramatic shift towards using platforms such as Zoom, Google Meet and Webex for group meetings has fundamentally altered our perception of the need to travel for business purposes. This presents an opportunity to further explore these options post-pandemic, as both a means to reduce GHG emissions and business-related expense.

**Energy Intensity**
Goal: 30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1.0% YOY thereafter.
Interim Target (FY 2020): -1.0%

**Current Performance: -13.5%**

| | FY 2015 | FY 2019 (PY) | FY 2020 | % Change from Baseline | % Change from Last Year |
|---|---|---|---|---|---|
| Purchased Utilities (MMBtu) | 95,494.3 | 85,228.3 | 81,502.9 | -14.7% | -4.4% |
| Purchased Renewables (MMBtu) | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| Goal-subject GSF | 1,053,588.0 | 1,039,342.0 | 1,039,342.0 | -1.4% | 0.0% |
| **Energy Intensity (Btu/GSF)** | **90,637.3** | **82,002.2** | **78,417.8** | **-13.5%** | **-4.4%** |

### *Energy Intensity Reduction*

**Performance Status**

In FY2020, Fermilab had no non-excluded facilities greater than 5,000 gsf with an energy use index (EUI) greater than 150 kBtu/gsf.

**Plans and Projected Performance**

Fermilab will continue to work towards reducing the energy intensity of goal-subject buildings.

### *EISA Evaluations*

**Performance Status**

In the final year of the four-year Energy Independence and Security Act (EISA) Section 432 schedule, Fermilab has completed energy evaluations on 100 % of goal subject building consuming 87% of total energy use. (3,523,502 gsf complete) Additionally, during the summer of FY2020, a Fermi GEM fellowship graduate student studying mechanical engineering performed an energy audit of the MC-1 facility. The energy audit report documented the energy profile of the facility and was well received.

**Plans and Projected Performance**

Fermilab will continue to perform energy and water evaluations of goal-subject facilities, completing evaluations of all facilities every four years. In FY2021FY2021, Fermilab plans to retro-commission 2 buildings, the D-0 Assembly Building and the Office, Technical and Education building. Additionally, the laboratory plans, energy audits in the following 5 buildings, Warehouse 1, Warehouse 2, HAB, Meson Detector Building, and MI-60.

### *Metering*

**Performance Status**

Fermilab's new buildings utilize the most current smart meters designed to monitor, track, and assess facility performance and energy consumption. Existing facilities are variably metered either at the building level or at the branch level, giving facilities management staff the ability to monitor energy consumption and identify and mitigate energy consumption issues.

The industrial cooling water (ICW) utility is comprehensively metered enabling the laboratory to manage ICW to sustain programmatic needs. Electric, natural gas, and domestic water meters are deployed less frequently on existing buildings, but issues are identified as they arise, and consumption is monitored by using branch metering.

A project to replace aged natural gas meters began in FY 2019 with the installation of new smart meters at the Central Utilities Building and Warehouse 1. The project to install 26 replacement natural gas meters was completed in FY2020 and the final power and network connections will be completed in FY2021FY2021. The FY2021FY2021 plan is to install 7 additional natural gas meters at new locations, which will complete the recommended metering for all-natural gas users on the site.

**Plans and Projected Performance**

Fermilab is planning to replace 28 aging & failing electric meters. The goal is to complete the installation of these new meters in FY2021FY2021.

One of Fermilab's PEMP goals for FY2021FY2021 is to assess options for a sitewide Energy Management Information System (EMIS). Fermilab will determine the optimal tool that is compatible with the current supervisory control and data acquisition (SCADA), metering & Building Automation (BAS) infrastructures while minimizing costs.

As part of Fermilab's campus modernization efforts, aging and failing utility meters will be replaced with smart meters. In FY2020, the laboratory's metering infrastructure was evaluated as part of a Strategic Utilities Assessment. As a result, Fermilab will be able to better plan for metering needs and funding. Fermilab will also conduct an evaluation of meters that will properly interface with the laboratory's supervisory control and data acquisition (SCADA) system. Previously Fermilab counted facilities metered by group feeder lines as 'individually metered.' Current data reflects only those metered at the unique facility location. The laboratory's ongoing metering plan to is implement meters at individual existing buildings as resources allow.

# Water Management

*Water Use and Management - Potable*

**Performance Status**

**Potable Water Intensity**

Goal: 20% potable water intensity (Gal per gross square foot) reduction by FY 2015 from a FY 2007 baseline and 0.5% YOY thereafter.
Interim Target (FY 2020): -0.5%

**Current Performance: 16.9%**

| | FY 2007 | FY 2019 (PY) | FY 2020 | % Change from Baseline | % Change from Last Year |
|---|---|---|---|---|---|
| Water Consumption (million gal) | 41.4 | 50.4 | 50.2 | 21.3% | -0.4% |
| Aquifer Recharge (million gal) | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| Total GSF | 3,398,290.0 | 3,493,502.0 | 3,523,502.0 | 3.7% | 0.9% |
| **Water Intensity (Gal/GSF)** | **12.2** | **14.4** | **14.2** | **16.4%** | **-1.4%** |

Potable water use at Fermilab remained elevated in FY2020. Water use intensity showed a 16.4% increase against the 2007 baseline. To track water use, Fermilab uses a continuous domestic water monitoring system to identify consumption anomalies and excursions. Increased water intensity remained elevated due primarily to several significant below ground leaks that were detected in Fermilab's aged water distribution infrastructure. The largest of these leaks persisted for six weeks and eluded discovery before it was found and repaired. It's estimated that 5.4 million gallons of water was lost due to the rupture. The leaks were large enough to overwhelm any reduction in overall use due to reduced staffing related to the pandemic.

The table below shows the top five facilities water use comparison between 2019 and 2020. Overall water use decreased in these facilities due primarily to reduced occupancy as site activity was curtailed due to the pandemic.

| Facility | *FY 2019 Kgal* | *FY2020 Kgal* | *Water Used Difference Kgal* |
|---|---|---|---|
| Wilson Hall | 3719 | 3199 | -520 |
| MC -1 | 564 | 558 | -6 |
| MC-2 / Mu2e | 136 | 378 | 242 |
| CMTF | 201 | 195 | -6 |
| HAB | 80 | 47 | -33 |
| Total Reduction | | | -323 |

*Facility water use comparison*

**Plans and Projected Performance**

Fermilab's five-year average potable water use is 35 million gallons per year. No significant increase in operational demand to potable water is anticipated for the next five years.

Fermilab anticipates the establishment of a large capital improvements Utilities Infrastructure Project (UIP). This project will include significant investment in potable water infrastructure upgrades that should

significantly reduce the frequency and volumes lost due to leaks. While funding has not been finalized, the intent is to replace a significant portion of the potable water system identified as inadequate or substandard.

### *Water Use and Management - Industrial, Landscape and Agriculture*

**Performance Status**

Virtually all ILA water used at Fermilab is contained in a semi closed loop surface and piped Industrial Cooling Water system (ICW). The system's primary purpose is to provide evaporative cooling for the accelerator complex and support equipment. Water is obtained principally from precipitation that falls on site which is captured and retained in an interconnected network of ponds, lakes and ditches. Precipitation is considered an alternative water source and therefore is not subject to efficiency goals.

**Non-Potable Water Consumption**

Goal: Non-potable freshwater consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA). YOY reduction; no set target.
Interim Target (FY 2020): 0.0%

**Current Performance: 19.5%**

| | FY 2010 | FY 2019 (PY) | FY 2020 | % Change | % Change from Last Year |
|---|---|---|---|---|---|
| Industrial | 81.3 | 51.7 | 97.2 | 19.6% | -36.4% |
| Landscaping | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| Agricultural | 0.0 | 0.0 | 0.0 | N/A% | N/A% |
| **Total Non-Potable Water (million gal)** | **81.3** | **51.7** | **97.2** | **19.6%** | **-36.4%** |

*Part of the NuMI underground facility from which water is captured and directed to Fermilab's ICW system.*

The ICW system is further supplemented by water collected from three sources:

- Groundwater collected from the bedrock formation that surrounds the 4,000-foot-long NuMI underground facility.
- Water pumped from the Fox River located 3 miles to the west and piped to the laboratory.
- Water pumped from a deep well on-site.

These supplemental sources are used to make up for water losses to the ICW system that occur from normal operations or during times of insufficient precipitation. Water in excess of the system's capacity is discharged off site by way of three creeks that intersect the site.

In FY2020, volumes from these three sources were as follows:

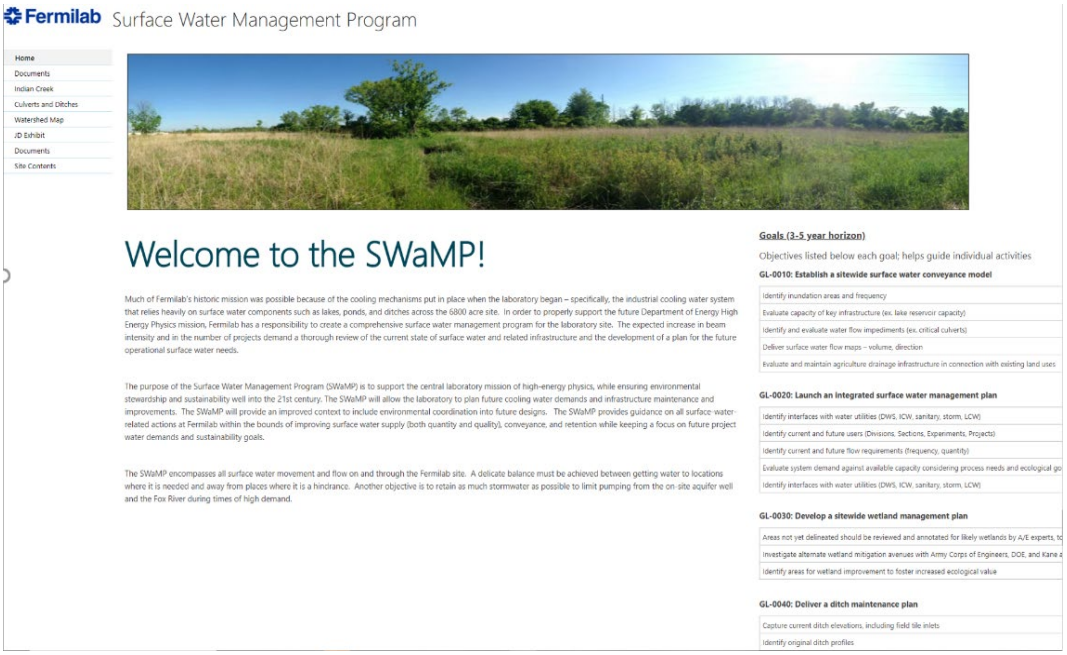
| Source | Total M gal |
|---|---|
| Groundwater from MINOS | 44.1 |
| Fox River | 22.9 |
| Deep aquafer well | 30.1 |
| Total Withdrawals FY2020 | 97.1 |
| Total Withdrawals FY 2010 | 81.3 |
| Difference | 15.8 |

ILA water usage for Fermilab in the DOE Sustainability Dashboard is calculated as the sum of the supplemental sources. Volume totals for 2020 represent an increase of 15.8 M gallons against the 2010 baseline year. The increase is attributable to greater withdrawals from both the Fox River and the deep well. The Fox River pumping station was used 53 days compared to zero run days in 2019. The deep well was run for a total of 34 day compared to 6 days in 2019. The increase in ILA water demand was partially due to work related to civil construction site preparation work associated with the Long Baseline Neutrino Facility project. As part of the project, a large cooling pond was drained and refilled using make up ICW water.

Fermilab has adopted a site-wide strategy of natural landscaping and native grassland management that requires a minimum amount of landscape watering. Minor amounts of non-potable ICW are used during times of drought to water ornamental trees. There is no use of potable or non-potable water for routine landscaping or the irrigation of crops at Fermilab.

**Plans and Projected Performance**

Virtually all ILA water at Fermilab is used to support the operation of High Energy Mission Specific Facilities (HEMSFs). Precipitation that falls on site dominates the water available for cooling use and as such is not subject to reduction goals. Fermilab actively seeks opportunities to increase the efficiency of the system. Overall water management on site is accomplished via our Surface Water Management Plan (SWaMP). The plan addresses both cooling water needs and other surface waters on site that are not part of operations. Additionally, anticipated future demands are factored into large projects such as the Proton Improvement Plan-II project and the Long Baseline Neutrino Facility project.



*Fermilab's Surface Water Management Plan homepage*

# Waste Management

## *Municipal Solid Waste*

### Performance Status

Fermilab operates an established comingled recycling program that includes the recovery of paper, glass, plastic and metal containers. The laboratory also recycles when possible various non-conventional items such as polystyrene packaging and disposable batteries. Additionally, a scrap metal program is used to divert significant volumes of salvaged metals generated as part of normal operations. In FY2020 Fermilab diverted 151 metric tons (44%) of the municipal waste generated on site.

**Municipal Solid Waste**
Goal: Divert at least 50 percent of non-hazardous solid waste (excluding construction and demolition debris)
Interim Target (FY 2020): 50.0%
**Current Performance: 44.3%**

| | FY 2020 | % |
|---|---|---|
| Off-Site Landfills | 188.3 | 55.3% |
| On-Site Landfills | 0.0 | 0.0% |
| Waste to Energy* | 1.3 | 0.4% |
| ***Non-diverted Waste*** | ***189.5*** | ***55.7%*** |
| Diverted Waste | 147.8 | 43.4% |
| On-Site Composted | 0.0 | 0.0% |
| Off-Site Composted | 1.8 | 0.5% |
| Waste to Energy Credit | 1.3 | 0.4% |
| ***Total Diverted Waste*** | ***150.9*** | ***44.3%*** |
| **Total Waste (metric tons)** | **340.4** | **100.0%** |

* For E.O. 13693, waste to energy does not count as diverted waste, but some credit may be applied

The diversion rate declined from previous years. It is believed that this was caused in part due to an increased volume of single-use, consumable items disposed of in association with managing the effects of the pandemic. Support staff to manage waste, including janitorial staff, were also less focused on recycling as stepped-up sanitation efforts became the priority. The total volume of waste diverted was comparatively reduced by 40% due to low occupancy of the site beginning in March, when employee access restrictions were put into place. Smaller amounts of waste diverted towards composting (1.8 tons) and recycled cooking oils (1.25 tons) also occurred.

Several more non-conventional recycling and repurposing programs were impacted to a lesser effect. These include a long-established agreement with local municipalities whereby neighboring cities are permitted to transport residential leaf litter they collect to Fermilab to be used as a soil amendment for lands used for row-crop agriculture on site. The municipalities brought to Fermilab approximately 7,500 cubic yards of leaves last year. Additionally, as part of grounds maintenance activities, the laboratory repurposed approximately 1,000 cubic yards of wood chips to be used as natural landscaping material around buildings and structures.

*Leaves collected by the City of Batavia and transported to Fermilab for incorporation as a soil amendment.*

**Plans and Projected Performance**

It is anticipated that waste volumes and associated diversion rates will remain low through most if not all of FY2021FY2021 due to the pandemic. Once laboratory operations return to normal, the overall impact of an increased number of employees that may choose to work remotely, or by varied on-site work schedules will be reviewed to determine the operational impact, including any adjustments that may be needed for waste management strategies.

### *Construction & Demolition Waste Diversion*

**Construction & Demolition**

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

Interim Target (FY 2020): 50.0%

**Current Performance: 52.4%**

| | FY 2020 | % |
|---|---|---|
| Landfilled C&D Waste | 146.1 | 47.6% |
| Diverted C&D Waste | 160.7 | 52.4% |
| **Total C&D Waste (metric tons)** | **306.9** | **100.0%** |

**Performance Status**

Fermilab diverted 163.04 metric tons (53%) of C&D waste in FY2020. There are currently three large construction projects occurring on site and each is recycling waste material. Activity on these projects was curtailed in spring due to the pandemic, however work has resumed for the most part for all three. Additionally, Fermilab has staged C&D recycling dumpsters at strategic locations around the site and these are used for small-scale projects. Overall, the total amount of C&D materials recycled was reduced by approximately 35% over previous years.

**Plans and Projected Performance**

Fermilab continues to advance best practices for the management of construction and demolition debris. The laboratory maintains a clear set of contract specifications and related requirements for all new construction projects that require C&D waste generated to be diverted when possible. A waste management tracking database for projects was expected to be online for FY 2120 however, due to disruptions from the pandemic this has been delayed. Once complete, data collection and management should be simplified and standardized.

As part of Fermilab's Master Campus Plan, various facilities are slated for removal, consolidation or replacement over the next decade. Waste generated with this work will adhere to Fermilab's recycling practices for demolition waste. Waste generated from the large-scale, multi-year projects currently underway is anticipated to increase significantly in the coming years. The primary projects at Fermilab currently generating substantial waste for recycling are the Integrated Engineering Research Center (IERC), the Proton Improvement Plan-II project and the Long Baseline Neutrino Facility.


*Antiquated porta camp trailers formerly used as office space are being demolished and recycled.*

# Fleet Management

**Performance Status**

*Fleet Management Strategies*

Fermilab's approach to fleet management is centered around the concept of smart fleet utilization. This approach is part of an integrated effort to provide transportation support throughout the facility. The goal is to partner with all units of the laboratory to provide an optimal blend of vehicles necessary to operate the facility. Fermilab's fleet consists of 168 of vehicles of which 27 are leased through GSA. More than half of the motor vehicle fleet is alternatively fueled, and this fuel type is used in all vehicles that can accept it. Recently, as a strategy to reduce fuel use, a site wide campaign was refreshed that encourages drivers to limit idling when not necessary.

*Fermilab encourages limiting vehicle idle times whenever possible*

The laboratory maintains a commitment to right size its fleet. A Fleet Utilization Committee, consisting of representatives from all organizations at the laboratory that use vehicles, meets quarterly to review fleet and usage issues. The group works collaboratively to ensure the fleet is at the appropriate level for mission need without excess or unnecessary vehicles. In 2020 six vehicles were replaced, five of which were AFV's. The fleet also includes one plug-in electric vehicle.


*Fermilab's vehicle fleet includes diesel operated fire trucks and support vehicles*

The laboratory has operated an on-site, on-call taxi service for many years. More recently, a fixed route shuttle has been added to better meet the needs of laboratory staff and visiting researchers that reside on site. This hybrid approach has provided additional flexibility by balancing the needs of employees to efficiently move around site during working hours while also providing on-site residences a standardized route to get to work in the morning and back home again in the evening. On average 11,500 passengers use this service annually.

This past year saw a significant reduction in fuel consumption due to work restrictions limiting on-site activities in response to the COVID-19 pandemic. Overall fuel use (gasoline, E85 and diesel) was reduced by 15,000 gallons (or 18 %) from last year. In the future, once past the pandemic, changes in work activities that may include more remote work styles could have a lasting, long-term effect on the number of vehicles needed and the amount of fuel used. The impact to Fermilab's fleet will be assessed as changes become evident.

**Plans and Projected Performance**

Fermilab anticipates transitioning most of its current fleet towards GSA leased vehicles by the end of FY2022. This will significantly decrease the average age of the fleet and leverage the benefits of reduced GHG emissions found in newer vehicles. Expanded infrastructure to support electric vehicle charging stations is also being incorporated in new construction and major redevelopment projects occurring on site.

# Clean & Renewable Energy

## Performance Status

### Renewable Electricity

Goal:"Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter.
Interim Target (FY 2020): 30.5%

**Current Performance: 10.0%**

| | FY 2019 (PY) | FY 2020 | % Change from Last Year | % Compliant |
|---|---|---|---|---|
| Grid Electricity | 274,375 | 217,492 | -20.7% | |
| On-Site Renewable Energy | 0 | 0.0 | N/A% | |
| Purchased Green Electricity | 0 | 0.0 | N/A% | |
| Renewable Energy Certificates | 23,000 | 20,000 | | |
| Bonuses | 1,705 | 1,721 | 0.9% | |
| **Total Renewable Electricity with Bonuses (MWh)** | **24,705** | **21,721** | **-12.1%** | **N/A%** |
| **Total Electricity Consumed (MWh)** | **274,375** | **217,492** | **-20.7%** | |

### Clean Energy

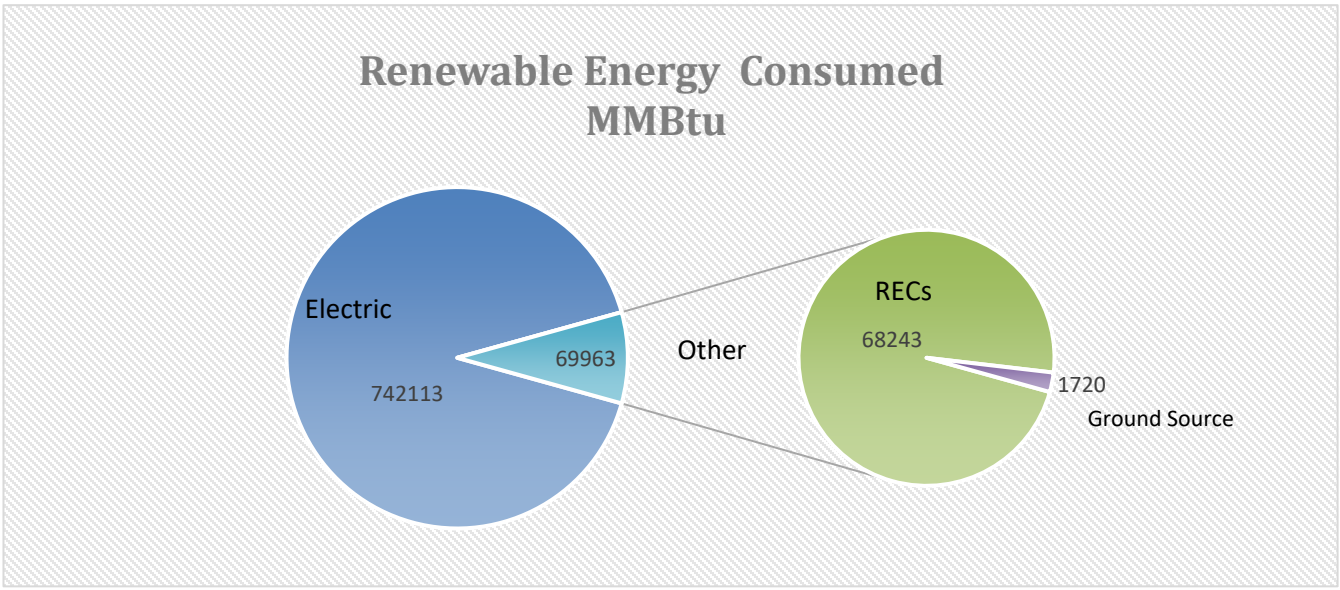
Goal: Continue to increase non-electric thermal usage. YOY increase; no set target but an indicator in the OMB scorecard.
Interim Target (FY 2020): 0.0%

**Current Performance: 9.0%**

| | FY 2019 (PY) | FY 2020 | % Change from Last Year | % Compliant |
|---|---|---|---|---|
| Grid Electricity | 936,167 | 742,084 | -20.7% | |
| Non-renewable Thermal Energy | 100,124 | 93,951 | -6.2% | |
| On-Site Renewable Energy | 0 | 0.0 | N/A% | |
| Purchased Green Electricity | 0 | 0.0 | N/A% | |
| Renewable Energy Certificates | 78,476 | 68,240 | -13.0% | |
| Bonuses | | | N/A% | |
| **Total Renewable Energy with Bonuses (MMBtu)** | **87,317** | **77,081** | **-11.7%** | **N/A%** |
| **Total Energy Consumed (MMBtu)** | **1,036,290** | **836,035** | **-19.3%** | |

Fermilab produced approximately 6 MWH/year of on-site clean and renewable energy. One facility, the Office, Technical and Education (OTE) building is heated and cooled by a ground source heat pump network and produced 1,720 MMBTU in FY2020. This is 85.3% the design output of 2,015.5 MMBTU, with the reduction from full output due to a lengthy outage of one of the compressor modules.

Fermilab purchased 20,000 MWH of renewable energy certificates (RECs) in FY2020, equivalent to 9.2% of the site's total annual electric energy consumption.



**Plans and Projected Performance**

Solar photovoltaic, solar hot water heating and other clean and renewable systems are regularly considered in all construction assessments, however due to Fermilab's very low energy utility rates these type of systems have not been found to be cost effective. Fermilab will continue purchasing RECs to meet current DOE goals until such time that alternative cost-effective opportunities for renewable power generation are identified.

Fermilab continues to explore renewable energy opportunities, including a preliminary investigation into a pilot program which has the potential to develop into a large-scale solar development through a Utility Energy Service Contract (UESC) contract with a solar developer. Cost effective renewable energy projects continue to be challenging to implement due the laboratory's very low energy utility rates. Fermilab is considering the use of solar photovoltaic and geothermal systems in the development of a new welcome and access visitors center, which is currently in preliminary design phase.

# Sustainable Buildings

## *Guiding Principles*

### Performance Status

As of FY2020, Fermilab has a total of 58 buildings over 10,000 GSF. Currently, 8 of the 58 buildings comply with the Guiding Principles for Sustainable Buildings (13.8% based on building count). Inventory of the 8 Sustainable Buildings is summarized below and totals 152,163 GSF of the 58 buildings totaling 1,747,143 GSF. (8% based on total square-footage).

| Building Name | Size (GSF) | Guiding Principle Checklist | | Compliance Year |
|---|---|---|---|---|
| | | Version | Type | |
| Office, Technical and Education (OTE) | 47,300 | 2008 GP | New Construction | 2014 |
| Industrial Center Building Addition (ICB-A) | 24,542 | 2016 GP | New Construction | 2019 |
| Site 37 Shop Roads and Grounds | 17,500 | 2008 GP | Existing Building | 2017 |
| HDCF – Grid Computing Center | 16,925 | 2008 GP | Existing Building | 2014 |
| Muon Collider-1 Building (MC-1) | 14,881 | 2008 GP | New Construction | 2017 |
| Short Baseline Neutrino Far Detector Building (SBN-FD) | 14,775 | 2008 GP | New Construction | 2017 |
| Muon Collider-1 Building (MC-2) | 11,000 | 2008 GP | New Construction | 2017 |
| Short Baseline Neutrino Near Detector Building (SBN-ND) | 5,240 | 2008 GP | New Construction | 2017 |
| TOTAL (8 Buildings) | 152,163 | | | |

*Guiding Principle Compliant Buildings - Completed*

### Plans and Projected Performance

As Fermilab approaches a particularly intense period of design and construction to support conventional facilities for the Long Baseline Neutrino Facilities and Proton Improvement Plan II, an additional 10 facilities are projected to be completed over the next 5 years. Additionally, 2 existing buildings are identified as candidates for sustainable modernization. The table below outlines the anticipated completion dates, sizes, and overall status for each project. When completed, these 12 facilities add an additional 277,238 GSF (29% of building count, 21% of square-feet) of compliant Sustainable Buildings to the Fermilab site.

| Building Name | Size (GSF) | Guiding Principle Checklist | | Projected Completion | Status |
|---|---|---|---|---|---|
| | | Version | Type | | |
| *New Buildings* | | | | | |
| Integrated Engineering Research Center | 79,208 | 2016 GP | New Construction | 2022 | Under Construction |
| PIP-II Cryogenics Building | 31,376 | 2016 GP | New Construction | 2022 | Under Construction |
| Target Systems Integration Building (TSIB) | 23,000 | 2016 GP | New Construction | 2023 | Final Design Phase |
| PIP-II Highbay Building | 21,275 | 2016 GP | New Construction | 2023 | Final Design Phase |
| Welcome and Access Center | 10,000 | 2016 GP | New Construction | 2023 | Preliminary Design Phase |
| PIP-II Linac Gallery | 32,905 | 2016 GP | New Construction | 2025 | Final Design Phase |
| LBNF-5 Primary Beam Service Building | 6,300 | 2016 GP | New Construction | 2020+ | Final Design Phase |
| LBNF-20 Target Complex | 32,789 | 2016 GP | New Construction | 2020+ | Final Design Phase |
| LBNF-30 Absorber Service Building | 5,650 | 2016 GP | New Construction | 2020+ | Final Design Phase |
| LBNF-40 Near Detector Service Building | 10,500 | 2016 GP | New Construction | 2020+ | Final Design Phase |
| TOTAL (10 Buildings) | 250,003 | | | | |
| | | | | | |
| *Existing Square-Footage* | | | | | |
| Industrial Building 3A (IB3-A) | 14,670 | 2016 GP | Existing Building | 2020+ | Assessed, pending Funding |
| Training Center | 9,565 | 2016 GP | Existing Building | 2020+ | Assessed, pending funding |
| TOTAL (2 Buildings) | 24,235 | | | | |

*Guiding Principle Compliant Buildings - Future*

### *Integrated Engineering Research Center*

Fermilab's new Integrated Engineering Research Center (IERC) received CD-3 approval to begin construction earlier this year. Construction for IERC is projected to be completed in FY2022. At this time, compliance with 17 of the 21 required metrics has been achieved. The integrated project team continues to track the progress of the remaining metrics and anticipates full compliance at completion. When completed, IERC will add an additional 79,208 GSF of compliant facilities to Fermilab's inventory.

*Rendering of IERC building currently under construction*

*Rendering of PIP-II Cryogenics Building currently under construction*

### *PIP-II Cryogenics Building*

As part of the extensive upgrade to Fermilab's accelerator complex, the Proton Improvement Plan-II will replace the 50-year-old existing Linac first stage accelerator. Construction for the PIP-II Cryogenics Building started earlier this year and is projected to be completed in FY 2022. Compliance with 16 of 21 required metrics was achieved prior to the start of construction. When complete, this facility adds an additional 31,376 GSF of compliant facilities to Fermilab's inventory.

# Acquisition & Procurement

**Performance Status**

In 2020 Fermilab applied sustainable acquisition requirements to all eligible contracts per Department of Energy Acquisition Regulations. Biobased purchases over the past year totaled $23,500. An established eMarketplace system helps the laboratory reduce the amount of paper requisitions by allowing employees the ability to place orders from the point of need.

| Sustainable Acquisition Application FY2020 | | | |
|---|---|---|---|
| Number of New Contract Actions Reviewed | Number of New Contract Actions without Opportunity for Sustainable Clauses | Number of New Contract Actions Containing All Applicable Sustainable Clauses | Total Number of New Contract Actions |
| 55 | 55 | 0 | 55 |
| 2 | 2 | 0 | 2 |
| 515 | 515 | 0 | 515 |

**Plans and Projected Performance**

In 2021 Fermilab will continue to explore opportunities to improve sustainable acquisition.

# Measurements, Funding & Training

**Performance Status**

Over the past 19 years Fermilab has completed six utility energy service contracts (UESCs, formerly called UIP) and energy savings performance contracts (ESPCs) valued at nearly $60 million. Measurement and verification (M&V) is performed annually by Ameresco for a 15-year energy savings performance contract (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.

| Summary of Sustainability Funding (K$) | | | |
|---|---|---|---|
| Category | FY20 Actual | FY21 Planned/ Requested | FY22 Projected |
| 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 | 216.4 | 226.2 | 235.2 |
| Renewable Energy Credits (REC) Purchase Costs | 23.6 | 37.8 | 50.7 |
| Total | 240.0 | 264.0 | 285.9 |

*Muon Campus Energy Audit*
A Fermi GEM fellowship graduate student performed an energy audit of the MC-1 facility in FY20. The study discovered several lighting ECMs which are listed on Fermilab's ECM workbook. It is hopeful that this student will return to perform similar energy audits next summer.

**Plans and Projected Performance**

Fermilab will continue to assess future opportunities including technology specific measures. Nicor, the local natural gas utility, has revamped its energy efficiency program for its high gas use customers. In FY2019, Fermilab used this service to assess several buildings. Nicor's audits formerly covered ECMs that benefit natural gas consumption only. The new program covers all building energy consumption. Fermilab is considering participation in this new program in the coming year.

The laboratory plans to perform retro-commissioning on 2 buildings, the D-0 Assembly Building and the Office, Technical and Education building. Additionally, the laboratory plans to perform energy audits in the following five buildings: Warehouse 1, Warehouse 2, HAB, Meson Detector Building, and MI-60.

While Fermilab is working towards the goal of having more sustainable buildings, we have coupled sustainable building audits to also include EISA audits. These combined audits were performed on 3 facilities in FY2019: The Training Center, IB3A, and PPD Office Building at D-0.

# Travel & Commute

**Performance Status**

A significant reduction to emissions associated with employee commuter travel occurred in FY2020. Emission reductions were the result of dramatically curtailed site activity by Fermilab staff beginning in March to minimize the spread of COVID-19. In a typical year, Fermilab's approximately 1,900 staff members commute back and forth to work, primarily by automobile, an average distance of 15.6 miles each way. An estimated 5.28 million fewer miles were driven by employees in 2020. This is the lowest recorded commuter mileage since sustainability reporting began in 2008. The reduction in travel produced an associated decrease in emissions of 35 %.

Emissions associated with airline travel have similarly decreased due to the same restrictions. In FY2020 emissions went down by 42 %, with 8.2 million fewer miles flown. Ground business travel decreased by 61%, with 145,000 fewer miles driven.

The number of telework agreements granting employees the ability to work from home transitioned nearly all staff to remote work as the pandemic became reality in the Midwest. While predicting the impact on the laboratory's work environment post-pandemic is difficult at this time, the vast shift in Fermilab's workforce towards telecommuting demonstrates a significant opportunity for change in the future. Fermilab has begun a large-scale telework pilot program involving major factions of the workforce to assess this opportunity.

| Organizational Telework Influence | | | |
|---|---|---|---|
| Year | Fixed Term | On Call | Regular |
| 2016 | 27 | 49 | 283 |
| 2017 | 2 | | 149 |
| 2018 | 2 | | 57 |
| 2019 | 4 | 1 | 80 |
| 2020 | 124 | 6 | 1,151 |
| Grand Total | 159 | 56 | 1,720 |

Just as in-person meetings have been replaced with teleconferencing options, conferences, workshops, and educational activities have transitioned to remote options as well. For example, the United States Particle Accelerator School (USPAS), coordinated by Fermilab, has moved to entirely remote sessions for the winter term. Attendance to the school is typically between 160 to 180 students. Similarly, Fermilab's annual Users Meeting for researchers was held remotely this past summer attracting virtual participation from institutions across the country and around the world.

**Plans and Projected Performance**

Fermilab has initiated a large pilot program to gauge the possibility of expanding telework opportunities across most sectors of the laboratory. This long-term pilot is aimed at identifying options for transitioning to a more flexible work environment for employees and researchers. This opportunity presented itself as constructive countermeasure to the drastic onsite work restrictions that were required to help limit the spread of the COVID-19 virus.

Fermilab is in the preliminary design phase for a new welcome and access center at the facility boundary near the main entrance to the site. This facility will be the gateway for all visitors, guests and most employees entering the Fermilab campus. The facility is being designed with an eye towards maximizing access to Fermilab via alternative transportation methods, such as public transportation, bicycle or pedestrian foot traffic.

# Fugitives & Refrigerants

**Performance Status**

Fugitive emissions continue to remain well below 2008 baseline releases. The laboratory currently maintains an in-house refrigerant management system based on regulatory refrigerant use protocols to minimize losses. This centralized system uses a database based on refrigerant mass balance accounting to track the use (and release) of refrigerants used across the site. The success of the management system has contributed to greater control of refrigerants.

In FY2020, following a review of the refrigerant management system completed in 2019, Fermilab's refrigerant manager created a policy and procedure for inclusion in the laboratory's environment, safety and health manual detailing handling and accountability measures for refrigerants. The refrigerant manager also provided Fermilab's stockroom staff an overview of the policy and implementation guidelines for handling refrigerants. Two members of Fermilab's Property Control Group were subsequently trained to use the management system's software. Following completion of this training they became credentialed as Certified Refrigerant Compliance Managers.

*Many fugitive emissions sources at Fermilab are innocuous.*

**Plans and Projected Performance**

Fermilab is transitioning its existing inventory of HVAC and refrigerant equipment using R22 towards newer systems using modern refrigerants that meet regulatory standards for ozone and lower greenhouse gas potential emissions. The laboratory's Centralized Facilities Management (CFM) organization actively seeks to replace many older, end-of-life HVAC units in both residential housing currently used in the Fermilab village, and larger facilities in operational areas on site.

# Electronic Stewardship

**Performance Status**

| Electronics Acquisition | | | |
|---|---|---|---|
| *Goal: 100 % of eligible electronics procurements must be environmentally sustainable.* ***Current Performance: 99.41%*** | | | |
| | EPEAT Acquired | Total Acquired | % |
| Computers & Displays | 937 | 938 | 99.89% |
| Mobile phones | 34 | 35 | 97.14% |
| Imaging Equipment | 1 | 1 | 100.00% |
| Televisions | 1 | 1 | 100.00% |
| Total Acquired | 973 | 975 | 99.41% |

Fermilab is committed to meeting the prescribed federal acquisition goals for electronic assets by purchasing qualified computing equipment which meet the Electronic Product Environmental Assessment Tool (EPEAT) registration requirements. Requisitioners must provide justification for any acquisitions that are not EPEAT registered. These justifications must be reviewed and approved by a designated approver. Purchases that may cause the failure to meet these goals may be denied.

Fermilab requires that all eligible desktops and laptops be centrally managed. Central management systems enforce power management settings as defined in the respective operating system baseline.

| Duplex Printing | | | | |
|---|---|---|---|---|
| *Goal: Implement and actively use duplex printing features of 100 percent of eligible printers* **Current Performance: 100%** | | | | |
| | Total Owned | PM Enabled | Exempt | % |
| Total Printers | 248 | 244 | 4 | 100% |

A user must submit a Power Management Exemption request for any monitor, laptop or desktop that cannot meet the Power Management settings. That request will be reviewed to determine if the provided business case is sufficient. If approved, the device will be added to the appropriate power management exemption group.

| Power Management | | | | |
|---|---|---|---|---|
| *Goal: Implement and actively use power management features on 100 % of eligible computers (PCs & laptops) and monitors* **Current Performance: 100%** | | | | |
| | Total Owned | PM Enabled | Exempt | % |
| Monitors | 0 | 0 | 0 | 0 |
| Computers | 5,280 | 4,402 | 878 | 100% |
| Total Items | 5,280 | 4,402 | 878 | 100% |

Fermilab lists all electronics on the federal General Services Administration (GSA) excess system that are condition code 1 (unused), 4 (used, working) or 7 (repairs required). If an asset does not get reused through the GSA excess system, it is disposed of by sending to a R2 recycler.

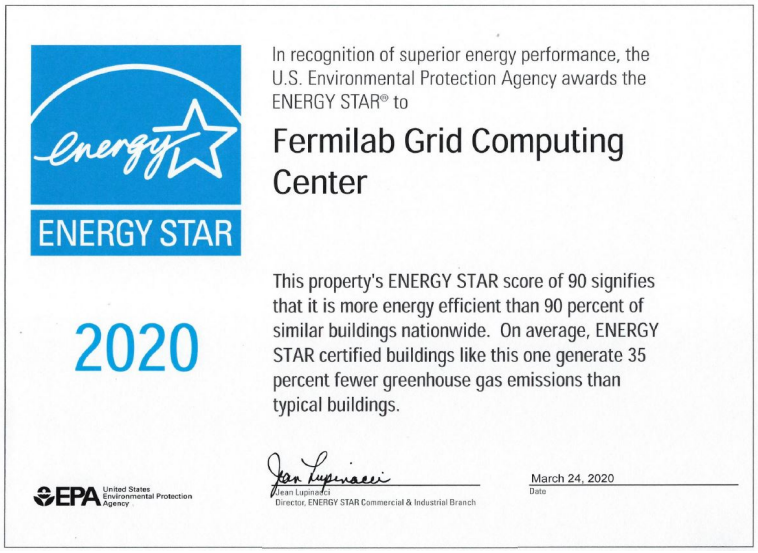
| Electronics Recycling | | |
|---|---|---|
| *Goal: Dispose of 100 percent of electronics through government programs and certified recyclers*<br>**Current Performance: 100%** | | |
| | Amount | % |
| Transferred or Donated | 1,212 pounds | 100% |
| Recycled by Certified Recycler | 30,571 pounds | 100% |
| Weight Transferred or Donated | | |
| Recycled by non-Certified Recycler | 0 | 0 |
| Amount disposed (e.g. landfill) | 0 | 0 |
| Total electronics waste (metric tons) | 31,783 pounds | 100% |

### *Data Center Power Usage Effectiveness*

***2020 Goal:*** **PUE 1.5**

***2020 Actual:*** **Feynman Computing Center PUE is 1.58 and the Grid Computing Center PUE is 1.71**

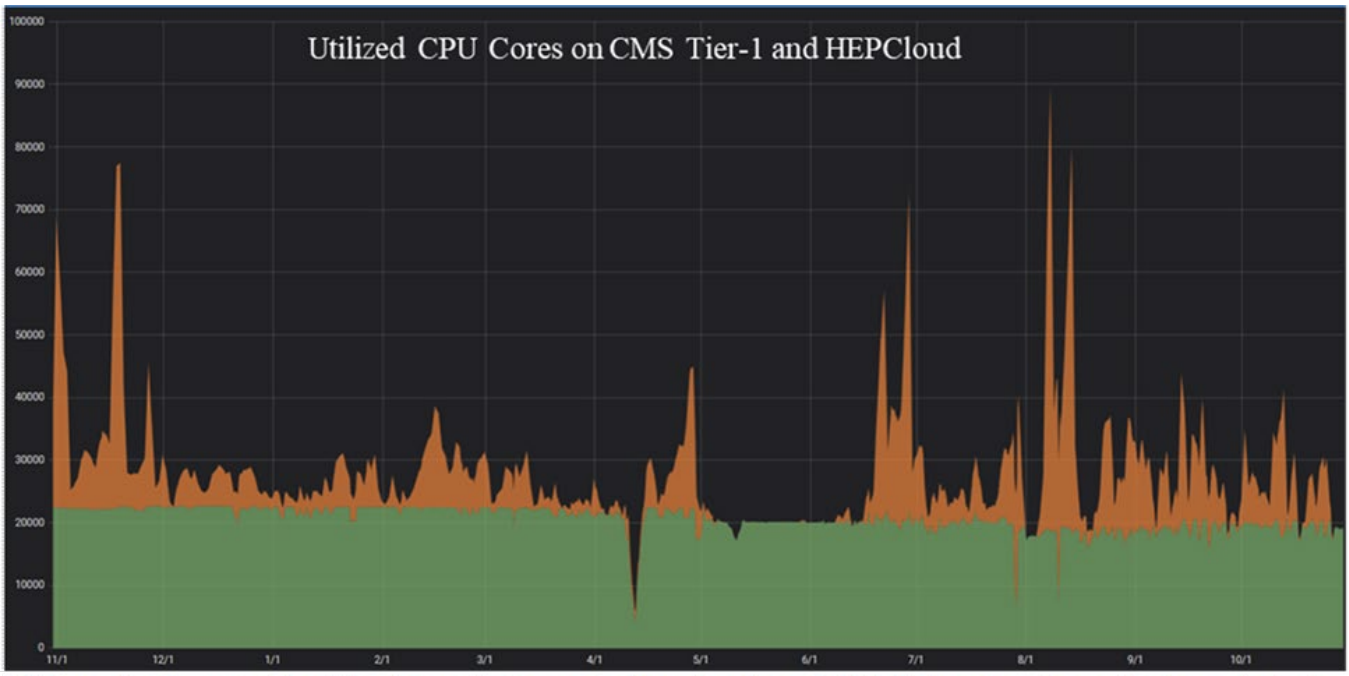
In FY2020 Fermilab successfully automated the collection of energy data, retrieving it from the FESS SCADA application, which reduces manual labor and improves accuracy. Other energy saving activities included rack plating, monitoring and tuning cooling within the data center rooms for optimal performance.




*Fermilab was awarded the Energy Star award for the Grid Computing Center in each of the last eleven consecutive years.*

### *HEPCloud Project*

Aspects of the Fermilab Scientific Computing Division HEPCloud project are now in routine operation. HEPCloud is the next step in the evolution of scientific computing; it is a scientific gateway to resources beyond local worker nodes and grids, expanding into high performance computing (HPC) centers and the cloud. HEPCloud allows scientific computing workloads to be directed to commercial cloud and High-Performance. Computing (HPC) resources. Through HEPCloud, Fermilab has extensively used the HPC facilities at the National Energy Research Scientific Computing Center (NERSC) for the Compact Muon Solenoid (CMS) experiment and executing scientific workflows for the Intensity Frontier NOvA experiment at scales orders of magnitude larger than resources available at Fermilab. The HEPCloud project is extending its reach into other DOE HPC facilities at Argonne and Oak Ridge.




*CMS experiment usage of local Tier-1 computing resources (green) and remote High-Performance Computing (orange) sites in prior year.*

An example of the ability to direct CMS workloads to external sites at levels surpassing local capacity is illustrated in the following figure. This allows full utilization of local resources without a need to over-provision to satisfy burst needs.

**Plans and Projected Performance**

In FY2021FY2021, Fermilab's data center efficiency is expected to improve. Most new services typically start on Virtual Machines (VM's) allowing the laboratory to avoid purchasing single purpose physical machines to run those workloads. We also continue purchases to replace spinning disk arrays hosting VM's with flash arrays, which consume far less space, cooling, and power. The savings estimate for migrating workloads from single purpose physical systems to VM's is more than $2.8M, or approximately 90% savings over approximately 9 years.

# Resilience

**Performance Status**

As described elsewhere in this Plan, the impacts to site operations due to the novel coronavirus pandemic were significant. In March, as the reality of the pandemic became clear, Fermilab quickly transitioned most laboratory staff to work remotely and curtailed lab operations to limit the spread of the virus. Onsite personnel were reduced to absolute minimum levels to ensure infrastructure integrity, site security and emergency response. Pandemic response was coordinated via Fermilab's Chief Safety Officer and a COVID-19 response task force was assembled. Means and methods to manage the site under restricted conditions were developed and deployed in alignment with CDC/federal guidance and Illinois requirements.

As regional restrictions eased in subsequent months, a phased return to onsite work plan balancing both risk and mission was implemented to permit additional personnel on site. Between May and September laboratory operations were slowly restarted until approximately 50% of the workforce was on site. Construction activities on the laboratory's large projects continued throughout as allowed by the state and DOE requirements for safe operations.

The following resilience initiatives were implemented in 2020:

- A Main Injector pond level detection and alarm system was installed to prevent cooling ponds from being inadvertently drained.
- Installed 25 smart gas meters and linked into Energy Managers dashboard for future reporting.
- Fifteen Category III natural gas repairs were completed and natural gas survey was conducted. Repairs resulted in multiple valves being replaced or added thus increasing system redundancy and flexibility in isolation for future work on the utility.
- Replaced Wilson Hall air handling unit dampers and actuators removing the last pneumatic controls in the building increasing reliability.
- Installed in-house custom sump pump monitoring stations at the Short Baseline Neutrino (SBN) Near, SBN Far, and Lab B facility for early fault detection in critical areas.
- Ozone Generator installed at Andy's Pond for evasive Zebra Mussel prevention treatment starting in Spring 2021.
- A concrete splash pad and swale path was constructed at SNB Far Detector to eliminate infiltration of discharge back into the lower level sump.
- Replaced failed triple duty water comfort loop valves at the Feynman Computing Center with separate high-performance valves and checks to increase system reliability.
- Installed new a duplex outdoor sump pump system at Lab B adding redundancy for protecting the experimental equipment in the lower level of the facility from flooding.

Beginning in 2021, Fermilab will begin a major project to improve the sanitary sewer system. Based on available funds, this project anticipates to repair, replace or reline approximately 14,000 linear feet of sanitary sewer pipe and services, repair or replace 140 manholes, and repair or upgrade mechanicals to eleven sanitary lift stations. A prioritized determination for improvements was based on a consultant's assessment of the most critical areas in need of upgrade. It is expected that upgrades to the sanitary sewer system will ultimately reduce sewage leak losses and improve excessive infiltration/inflow that currently occurs during periods of large precipitation, which occasionally overwhelms system capacity.

**Plans and Projected Performance**

Fermilab has developed a 10-year strategy for recapitalizing or dispositioning overaged, obsolete and severely deteriorated aspects of the laboratory's infrastructure, and constructing new infrastructure to close identified infrastructure gaps and improve operational resilience. The strategy is comprised of 128 prioritized infrastructure projects that directly support and/or enhance either: the laboratory's scientific mission; the reliability of lifeline infrastructure such as water, sewer, and electrical distribution systems; modernize laboratory workspaces; or security of the laboratory. In conjunction with this strategy, Fermilab's Campus Master Plan was re-assessed for current applicability in support of the implementation of strategic plan and major initiatives.

*Photo LBNF site preparation work. A 500-foot-long box culvert was constructed to redirect Indian Creek to flow under a portion of new permanent hill needed for the project. The culvert includes a naturalized channel for fish. Photo: Ryan Postel, Fermilab*

A funding profile is being coordinated with DOE to carry out this strategy. The Utilities Infrastructure Project (UIP), which will seek to make major investments in upgrading infrastructure, is currently supported by DOE at the CD-0 level. The plan is separated into three primary phases.

Phase one: Fermilab anticipates the construction of a new chilled water plant and the renovation of the existing Central Utility Building (CUB). A newly constructed chilled water plant will provide for dynamic expansion as cooling demands increase resulting from upgrades to the laboratory's accelerator complex and associated experimental infrastructure. Additionally, modern chillers will be more energy efficient, and a larger facility will provide flexibility and additional redundancy to reduce operational plant downtime that may cause accelerator outages. Renovating the existing CUB will provide a refresh for water treatment and hot water boilers systems which will increase their efficiency and dependability.

Phase two: Replacement of the Kautz Road Substation. The primary benefit of this work will be the elimination of safety concerns related to arc flash. Additionally, energy efficiency will be reviewed, however it is unclear if this phase will provide electric savings. Substation metering will be evaluated for modernization. It is anticipated that substation reliability will improve with the replacement of end of life equipment.

Phase three: Repair and or replace primary linear utility systems across the site including potable water, chilled water, industrial cooling water, storm sewers, and electrical distribution infrastructure. In addition to reducing outages caused by faulty utilities, theses upgrades will have the benefit of reducing waste. For example, breaches in drinking water lines ultimately waste the natural resource and make it unavailable for use.

# Executive Summary Table

| Prior DOE Goal | Current Performance Status | Planned Actions & Contribution | Overall Risk of Non-Attainment |
|---|---|---|---|
| ***Energy Management*** | | | |
| 30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1.0% YOY thereafter. | 13.5% Reduction | Fermilab will continue work to reduce energy intensity of goal-subject buildings | Low |
| EISA Section 432 continuous (4-year cycle) energy and water evaluations. | In Compliance | In FY2021FY2021 and beyond Fermilab will continue to pursue energy & water assessments where economically feasible. | Low |
| Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate. | 100% New Buildings Metered<br><br>Existing Buildings:<br>55% electricity<br>61% natural gas<br>7% water<br>(no steam) | Historically Fermilab counted facilities metered by group feeder lines as 'individually metered.' Current data reflects only those metered at the unique facility location. Plan is to implement meters at individual existing buildings as funding and resources allow. | Medium |
| ***Water Management*** | | | |
| 20% potable water intensity (Gal per gross square foot) reduction by FY 2015 from a FY 2007 baseline and 0.5% YOY thereafter. | 16.5% Increase | Chronic ruptures in the water supply system due to failures from aging infrastructure make goal attainment unpredictable and challenging. Future system upgrades planned as part of UIP II. | High |
| Non-potable freshwater consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA). YOY reduction; no set target. | 19.5% Reduction | Changes to make up water supply for the industrial cooling water system depends primarily on fluctuations associated with precipitation collected on site, and the ability to pump from the Fox River. Fermilab's overall ILA consumption remains relatively consistent YOY. | Low |
| ***Waste Management*** | | | |
| Reduce at least 50% of non-hazardous solid waste, excluding construction and demolition debris, sent to treatment and disposal facilities. | 44.3 % Reduction | Evaluate diversion/recycling practices. Ensure new facilities participate with program. | Medium |

| Prior DOE Goal | Current Performance Status | Planned Actions & Contribution | Overall Risk of Non-Attainment |
|---|---|---|---|
| Reduce construction and demolition materials and debris sent to treatment and disposal facilities. YOY reduction; no set target. | 52.4% | Onsite projects will continue to divert construction and demolition debris into reuse or recycling streams. Anticipate continued success in meeting and exceeding the 50% diversion rate target. | Low |
| ***Fleet Management*** | | | |
| 20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline and 2.0 % YOY thereafter. | Goal Met | Reduction goals consistently met. | Low |
| 10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter. | Goal Met | Alternative fuel is used in all fleet vehicles that can accept it. | Low |
| 75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV). | Goal Met | Five of six vehicles purchased in FY2020 wear AFVs. | Low |
| ***Clean & Renewable Energy*** | | | |
| "Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter. | 8.5% Energy used from renewable sources. (RECs used to meet goal) | Continue to purchase Renewable Energy Certificates (RECs) to meet renewable energy targets. | Low |
| Continue to increase non-electric thermal usage. YOY increase; no set target but an indicator in the OMB scorecard. | Continue to evaluate opportunities | New facilities in planning and design stages will be evaluated for renewable and non-electric thermal energy systems, while also being designed and constructed to meet Guiding Principles. | Low |
| ***Green Buildings*** | | | |
| At least 15% (by count) of owned existing buildings to be compliant with the *revised* Guiding Principles for Sustainable Buildings by FY2021FY2021, with annual progress thereafter. | 13.8% Meet Guiding Principles | New facilities in planning and design stages will be designed and constructed to meet Guiding Principles. Anticipated new facilities will surpass GP goal requirement. | Low |
| ***Acquisition & Procurement*** | | | |

| Prior DOE Goal | Current Performance Status | Planned Actions & Contribution | Overall Risk of Non-Attainment |
|---|---|---|---|
| Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in all applicable contracts. | 100% | Continue to include requirements for sustainable acquisition and procurement in contract terms and will seek opportunities to improve opportunities for requisitioners to choose sustainable alternatives. | Low |
| ***Measures, Funding, & Training*** | | | |
| Site set annual targets for sustainability investment with appropriated funds and/or financed contracts for implementation. | Continue to evaluate opportunities. | In FY2021FY2021 and beyond, Fermilab will continue to consider opportunities for ESPC/UESC and other financing methods to support sustainability performance. | Low |
| ***Electronic Stewardship*** | | | |
| End of Life: 100% of used electronics are reused or recycled using environmentally sound disposition options each year. | 100% | Fermilab will continue to dispose of all end of life electronics through certified reuse or recycling programs/facilities. | Low |
| Data Center Efficiency: Establish a power usage effectiveness target for new and existing data centers; discuss efforts to meet targets. | **1.5** | Continue pursuing activities such as rack plating, monitoring and tuning cooling centers to optimize performance. | Medium |
| ***Organizational Resilience*** | | | |
| Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols. | Ongoing | Fermilab will continue to develop methods for integrating climate resilience techniques into emergency response, site planning, facility development and renovation processes. | Low |
| ***Multiple Categories*** | | | |
| YOY scope 1 & 2 GHG emissions reduction from a FY 2008 baseline. | 72.2% | Continue to pursue activities reducing Scope 1 & 2 emissions. | Low |
| YOY scope 3 GHG emissions reduction from a FY 2008 baseline. | 77.9% | Continue to pursue activities reducing Scope 3 emissions. | Low |