

Energy management at **FERMILAB**: strategy on energy management, efficiency, sustainability

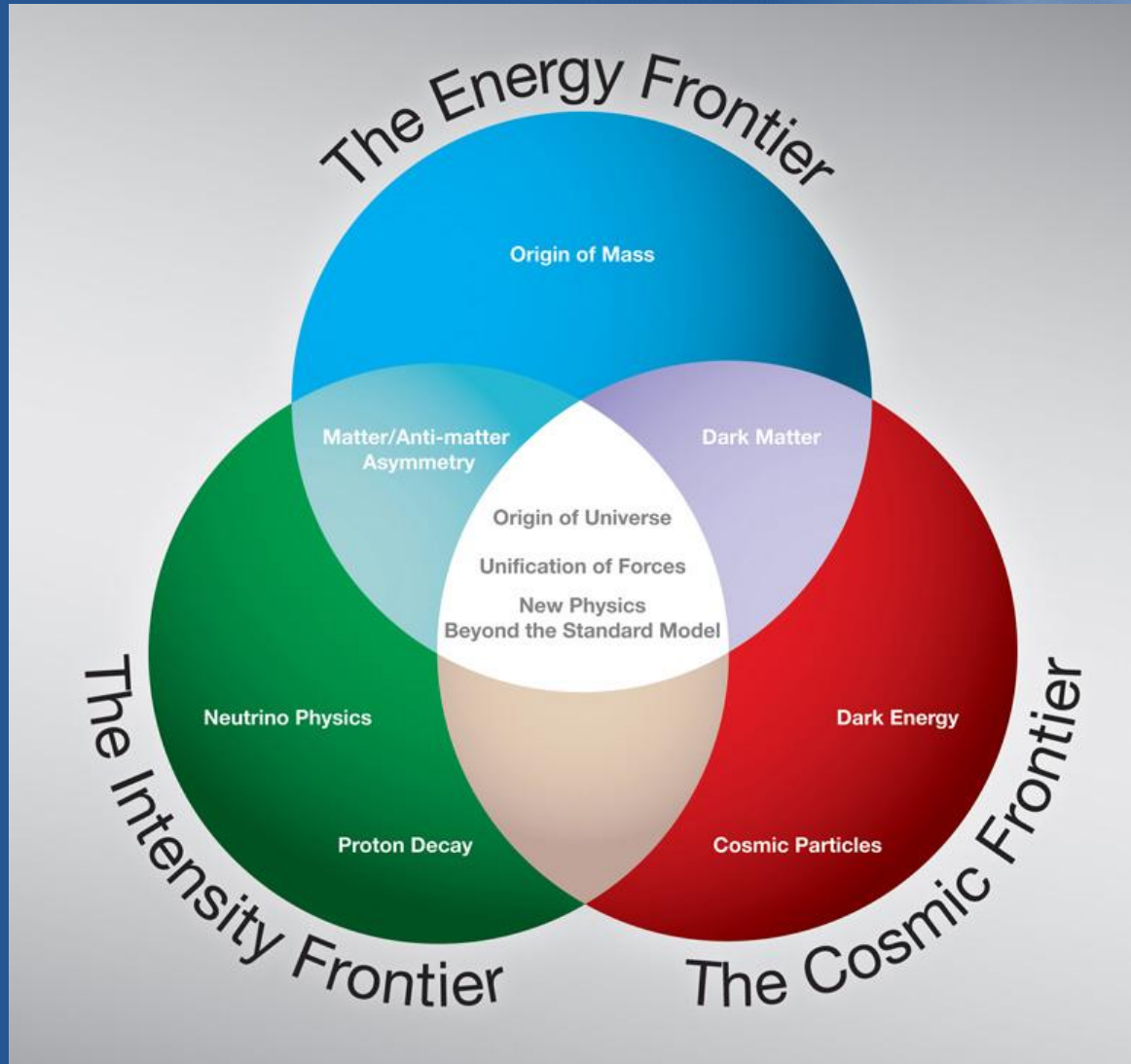
Stephen Krstulovich, energy manager



Fermilab at the Frontiers

- Since the transfer of most research at the Energy Frontier to CERN, Fermilab participates as one of CERN's international collaborators in this area with both personnel working at CERN and a control room for CMS on the Fermilab site
- Fermilab has currently shifted its emphasis to research in the Intensity and Cosmic Frontiers with projects on site and at other locations
- Planning for future machines such as a Muon Collider could enable Fermilab to lead in both the Intensity and Energy Frontiers once again

The Frontiers of Particle Physics



Energy for Some Major Fermilab Initiatives

- NOvA may add 8 MW to the Main Injector and increase site loads by 15%
- Accelerator R&D may add 8 MW to SRF facilities and increase site loads by 15% or more
- LBNE may add over 3 MW in the mid term and increase site loads by 5% and more long term
- Muon g-2 may add over 3 MW and increase site loads by 5%
- Beyond FY2020 Neutrino Factory and Project X may add much more long term to site loads

Fermilab Reconfiguration Planning



Features of Fermilab Reconfiguration

- LBNE is a primary long term initiative to study rare events of the Intensity Frontier by sending neutrinos to Homestake mine in South Dakota
- Muon experiments are mid term initiatives that may eventually help lead to the development of a Muon Collider
- Superconducting test facilities are short term initiatives that create expertise in developing more efficient accelerator technologies to be used both at Fermilab and elsewhere

Efficiency Improvements from SRF



SRF and Other Initiatives

- Develop High Q Superconducting RF (SRF) cavities that reduce heat load at 2°K and minimize cryogenic system power requirements
- Develop new industrial technologies to mass produce High Q SRF cavities for new large accelerators
- Investigate Optical Stochastic Cooling to improve beam luminosity for experiments
- Investigate nonlinear integrable beam optics to improve efficiency by reducing accelerator resonance

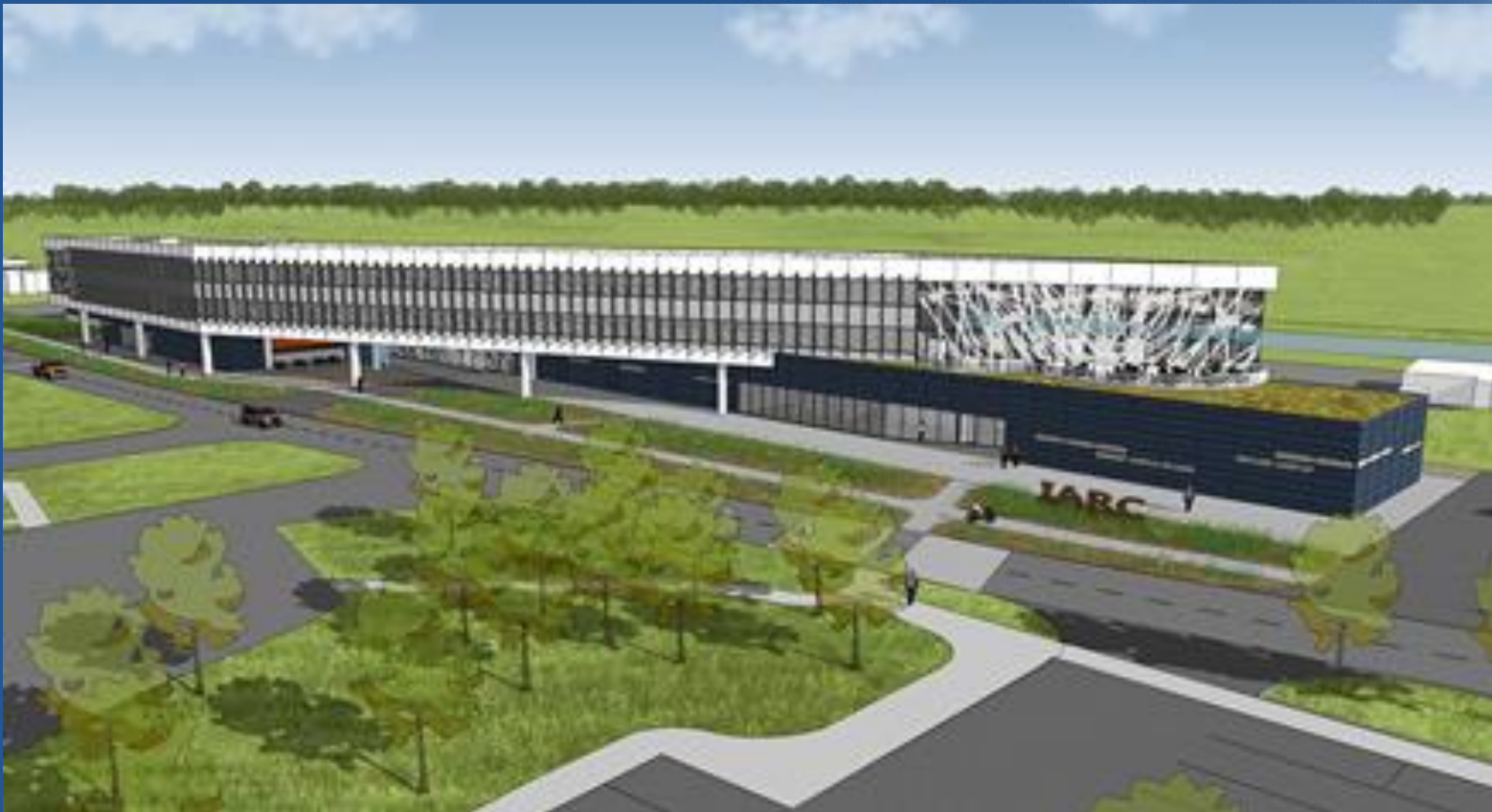
Efficiency Improvements from IOT



IOT and Other Initiatives

- Develop high efficiency RF sources to replace the current use of inefficient Klystrons
- Develop alternative efficient Induction Output Tube (IOT) RF sources for new continuous wave accelerator applications
- Investigate solid state RF sources
- Investigate Energy Recovery Linac applications to recycle the kinetic energy of decelerated particles with low beam emittance

Fermilab IARC Facility



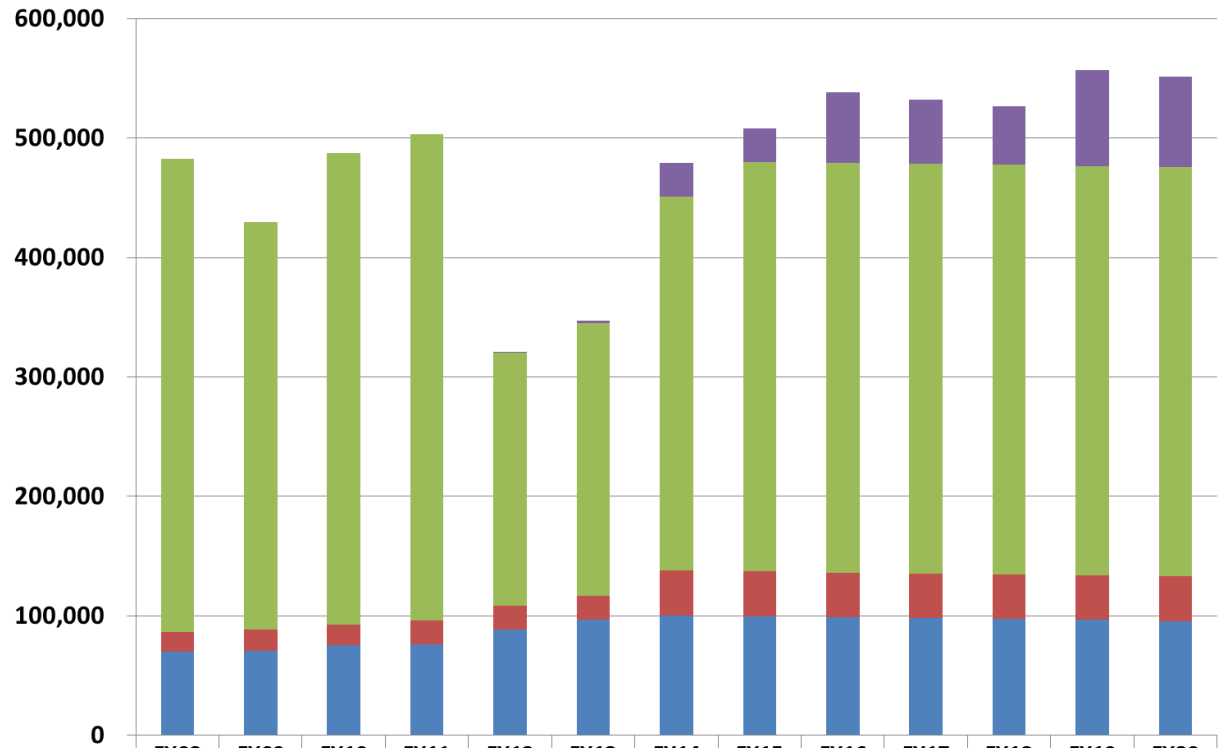
Illinois Accelerator Research Center

- Scientists and engineers from Fermilab, Argonne and Illinois universities will work with industrial partners to research and develop breakthroughs in accelerator science and applications for the nation's benefit
- Serve as a training facility for a new generation of scientists, engineers and technical staff in accelerator technology
- New facility designed to LEED gold status with State funding and includes geothermal energy, heavy use of local and recycled materials, and recycling of nearly all the construction waste

Future Mid Term Fermilab Power Needs

Electricity Projections for Fermilab

MWH



	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
■ New Accelerators HEMSF	0	0	0	0	876	2,000	28,280	28,280	58,940	53,684	49,304	79,964	75,584
■ Existing Particle Accelerators HEMSF	395,627	341,569	394,742	407,331	211,897	228,567	312,818	342,818	342,818	342,818	342,818	342,818	342,818
■ Existing High Performance Computing HEMSF	16,759	17,426	17,430	19,925	19,925	19,925	37,445	37,445	37,445	37,445	37,445	37,445	37,445
■ Site Base	70,060	70,966	75,366	75,922	88,302	96,508	100,457	99,617	98,799	98,004	97,230	96,477	95,744

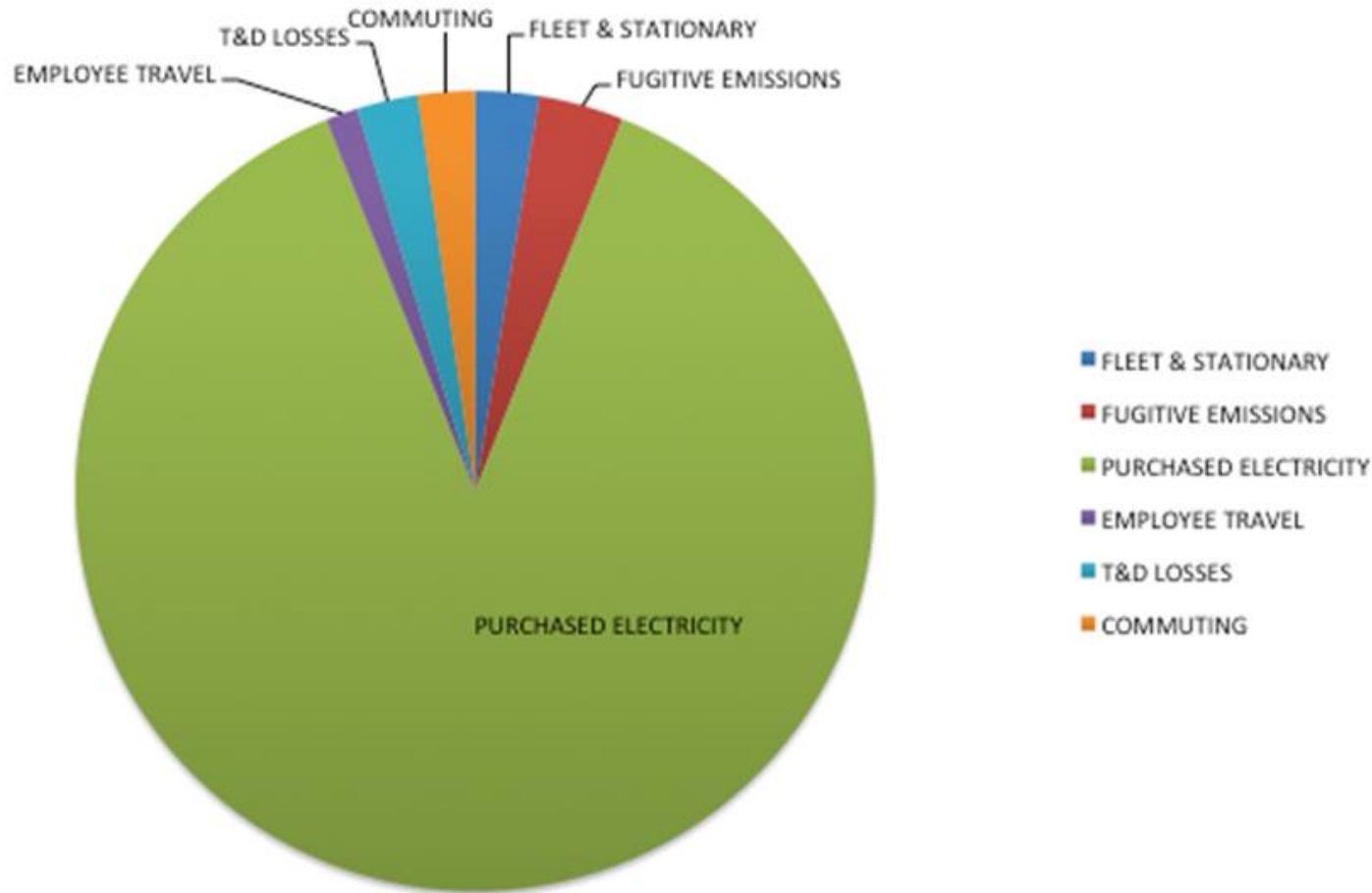
Fermilab Energy Conservation Process

Goal: By FY2020 reduce site GHG emissions by 28% from FY2008 levels

- Evaluation of renewable energy opportunities on site at least every 4 years
- Audit every facility on site for energy and water conservation opportunities every 4 years
- Implement in a timely manner any cost effective energy and water conservation measures (ECMs) identified
- Provide annual M&V of ECM energy savings

GHG Impact of Fermilab Operations

Significant Contributors to GHG Emissions at Fermilab



Fermilab Sustainability Practices

- Used over \$60M USD in alternative financing to implement energy and water conservation measures without upfront cost
- Used alternative financing vehicles such as UESC and ESPC to conduct audits and implement ECMs in a timely manner with annual M&V without upfront cost
- Used Renewable Energy Credits (RECs) to meet most of the GHG goals until cost effective renewable energy can be developed and implemented on site

Fermilab Portfolio Approach

- As a US Department of Energy (DOE) national laboratory, Fermilab's sustainability goals are tied to the entire portfolio of DOE laboratory sites under the Office of Science
- If cost effective energy solutions are not possible at any particular lab, the DOE goal may be still be achieved by combining the performance of all sites
- If combining sites does not achieve the goal, DOE can invest in the most promising sites to achieve the portfolio goal most cost effectively

Fermilab Computing Initiatives

- Virtualized 290 servers in the last 2 years and will virtualize another 110 servers next year
- Improved PUE by operating data centers at a higher power capacity
- Added hot and cold aisles, cold aisle containment on row ends, blanking and threshold panels, and higher cold aisle temperatures
- No cabling under raised floors, air conditioner ducting to hot air layer, matching air conditioning to temperature sensors in front of computer racks
- Improved electrical efficiency by transitioning more 120V electrical load to 208V distribution
- Use of UPS units with greater than 90% efficiency

Other Fermilab Sustainability Initiatives

- Procedures used for power management of monitors, laptops, processors, and printers
- Energy specifications for scientific computer purchases are included in solicitations
- Electronic equipment at end of life is either donated or recycled
- Sustainable Acquisition (SA) program is one aspect of Fermilab's Pollution Prevention and Waste Minimization program and helps Fermilab to reduce its impact on the environment

Other Fermilab Sustainability Initiatives

- 70 percent of vehicles are alternatively fueled, with the goal to increase to 100%
- Use of low VOC, solvent-based parts washing units to clean and de-grease machined parts
- Major use of recycled equipment and material
- Land and water management practices minimize contamination of the environment
- Dramatic reduction in fugitive emissions like SF₆
- Site wide recycling program with sub-contractor
- Storm water retention for process cooling