Sustainability in Proton Improvement Plan – II

**PIP-II Project Overview**

PIP-II is an essential enhancement to the accelerator complex and will enable the world’s most intense beam of neutrinos to the international LBNF/DUNE project. PIP-II will use the latest advances in superconducting radio frequency (SRF) technology to produce a 1.2 MW, upgradable and efficient, proton beam.

**SRF vs Normal Conducting Technology**

For linear accelerators, there are two options for the type of accelerating technology to use: superconducting or normal conducting (room-temperature) cavities. There are benefits and drawbacks to each type.

- **Superconducting Cavities**
  - No thermal problems
  - Less RF power
  - Smaller amplifiers
  - Continuous wave (CW) operation

- **Normal Conducting Cavities**
  - Less tolerant against beam loss
  - Cryogenic system required
  - Complicated cavity fabrication (expensive)

SRF technology was chosen for PIP-II because it is more flexible (pulsed and CW operation), scalable (higher power), and “future-proof” than normal conduction. In addition, SRF technology is still advancing, and its efficiency can still be improved while normal conducting cavities have reached their design maturity. Ultimately SRF technology will allow PIP-II to run more efficiently and use less power, resulting in operational cost savings for the lab.

**Sustainable Buildings**

All PIP-II buildings will meet DOE Guiding Principles for Sustainable Federal Buildings and Fermilab sustainability goals.

**Case Study: Solar PV on Linac Complex**

The project investigated the possibility of covering the roof of the Linac Complex (~1 acre) with solar panels.

<table>
<thead>
<tr>
<th>Linac Complex Roof</th>
<th>PIP-II Load</th>
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<tbody>
<tr>
<td>1 acre</td>
<td>55 acres</td>
</tr>
<tr>
<td>0.475 MW</td>
<td>26 MW</td>
</tr>
<tr>
<td>$1.4 Million</td>
<td>$77 Million</td>
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**PIP-II Sustainability Workshop**

Held in December 2021, the workshop’s purpose was to brainstorm ideas, explore strategies, and to develop executable plans to improve sustainability features for PIP-II. Over 28 opportunities were identified ranging across multiple disciplines. The primary themes were:

1. Energy management at accelerator facilities
2. Energy efficient technologies
3. Campus and building management
4. Energy recovery
5. Waste heat recovery

Prototype SSR1 cryomodule built for PIP-II. Implements current cutting edge SRF technology to accelerate proton beam in 800 MeV Linac.