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Painesville Municipal Power Vanadium Redox Battery Demonstration Project

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Ashlawn Energy

Funded in part by the Energy Storage Systems Program of the U.S. Department Of Energy through *National Energy Technology Laboratory*

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US Produced Vanadium Redox Flow Battery for Bulk Storage, Peak Shaving

- 8 MWh redox flow battery (1MW 8 hours)
- To be installed at Painesville Municipal Electric Plant (PMEP), a 32 MW coal fired facility
- Most efficient PMEP operation is steady state at 26 MW (lowest emissions, lowest operating cost)
- Nominal PMEP power demand ranges from 19 MW to 37 MW
- 8 MWh battery to demonstrate benefits of energy storage at PMEP

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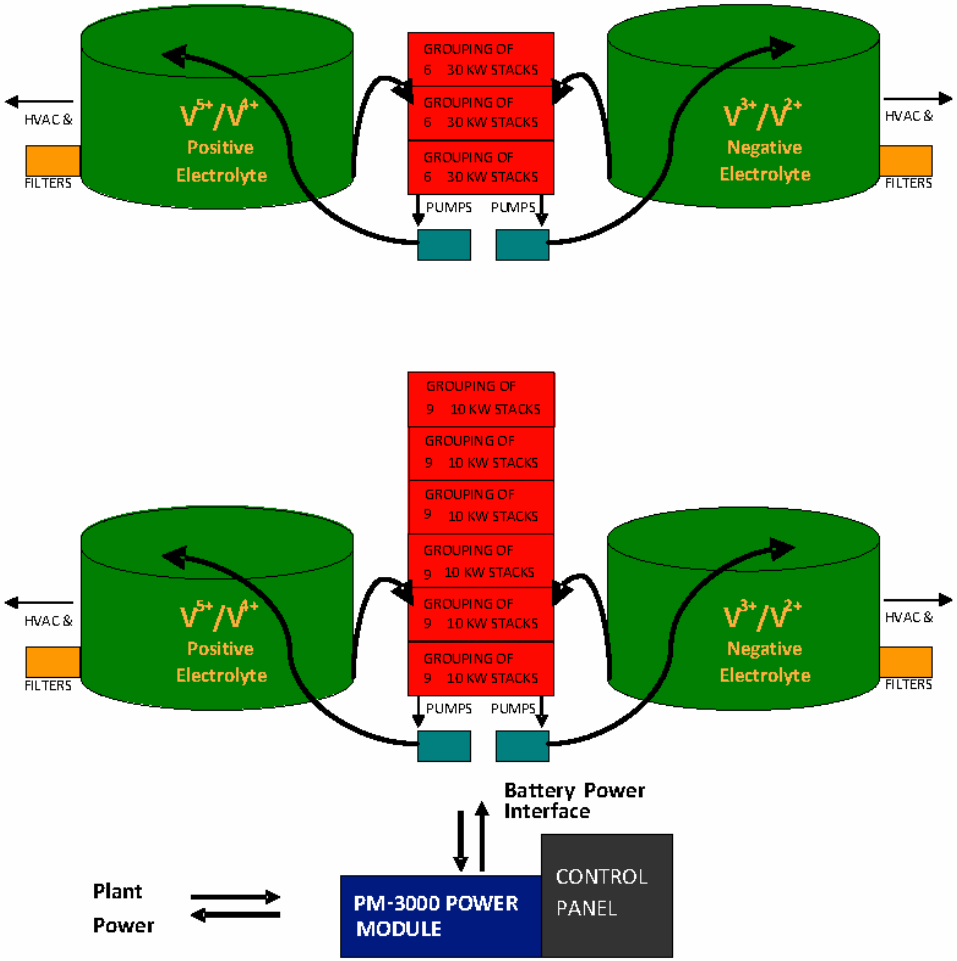
Painesville Battery Layout



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Project has Multiple Related Objectives

- Establish/Use US Manufacturing Base
  - Stack components/stack fabrication
  - Electrolyte
  - Power Conditioning System
- Demonstrate Efficacy/Reliability of latest Redox Flow Battery Design
- Cost Reduction
- Platform for Commercially Viable Product

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US Based Producers

- GrafTech International – Plates/Felt
- Strategic Minerals Corporation – Electrolyte
- DuPont and/or Ohio Producers – Membrane
- Innoventures – Stack Components/Stack
- American SuperConductor - Inverter

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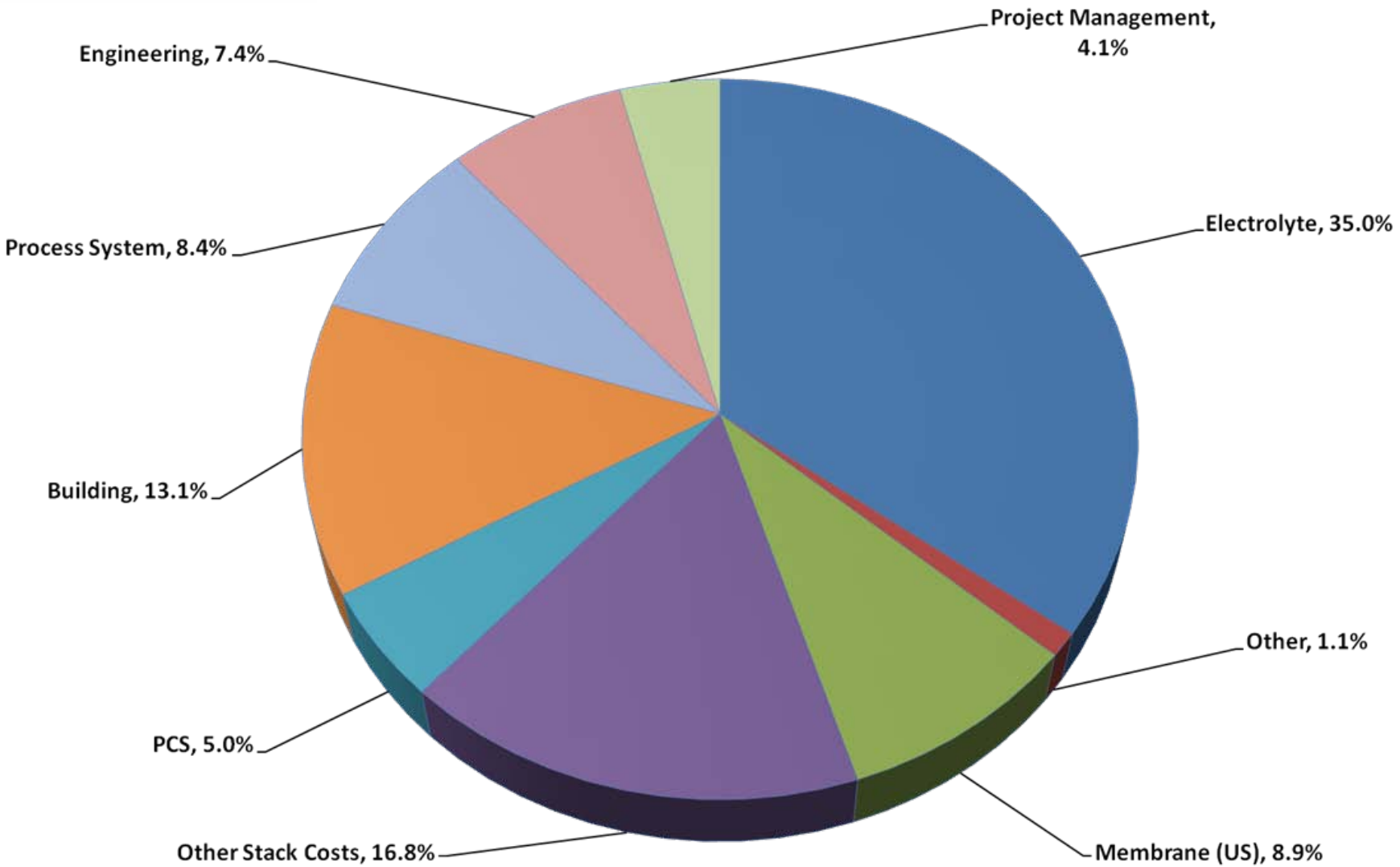
Major Cost Drivers Painesville

(US Sources)



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Targeted Improvements

- Vanadium Electrolyte from 1.75 M to 3.12 M
- Stack Size from standard 5 kW to 30 kW
- Power Inverter Efficiency (2% increase)
- Process System Efficiency (5% increase)
- Reduced foot print

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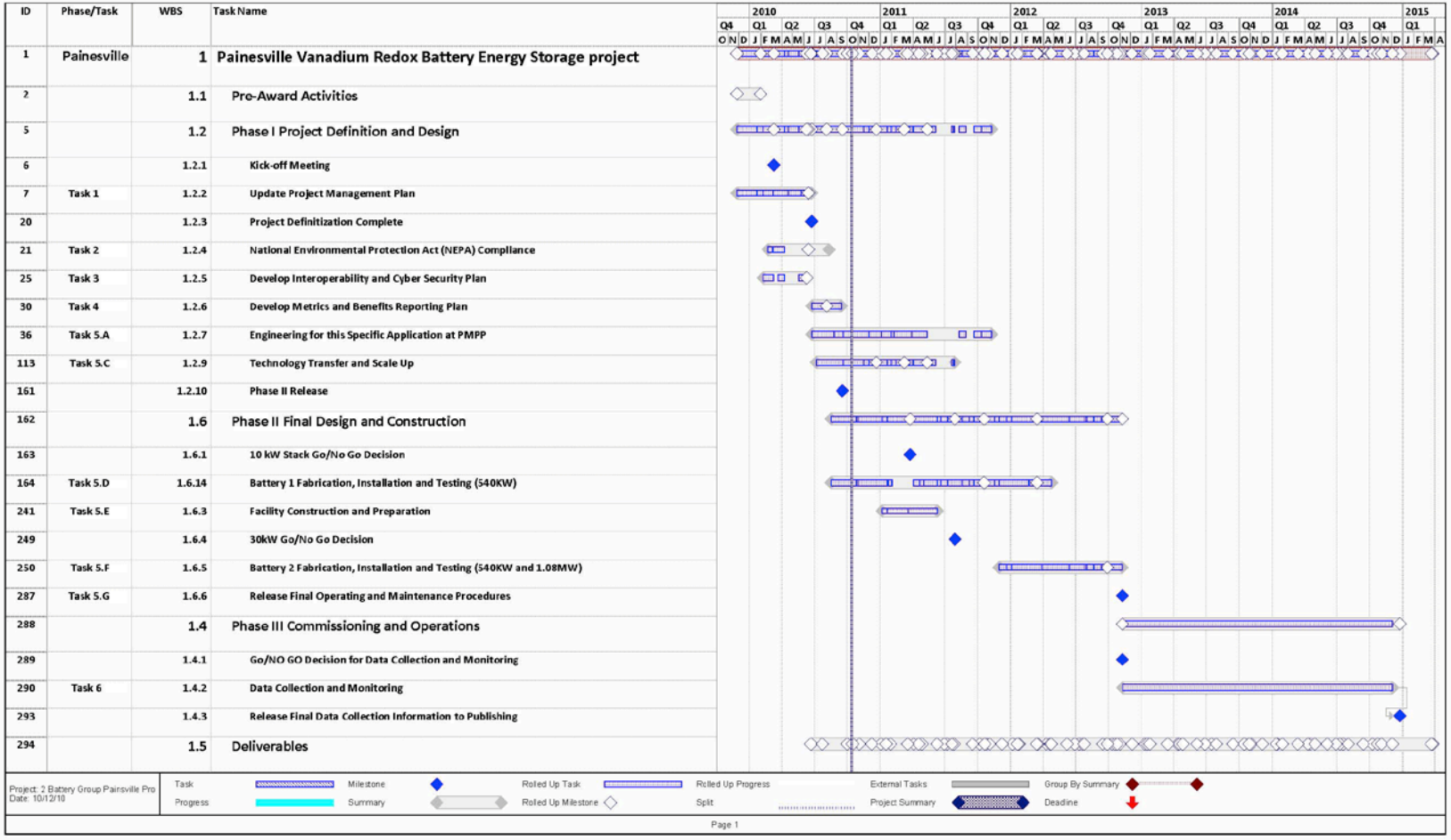
Overall Schedule



ID	Phase/Task	WBS	Task Name
1	Painesville	1	Painesville Vanadium Redox Battery Energy Storage project
2		1.1	Pre-Award Activities
5		1.2	Phase I Project Definition and Design
6		1.2.1	Kick-off Meeting
7	Task 1	1.2.2	Update Project Management Plan
20		1.2.3	Project Definitization Complete
21	Task 2	1.2.4	National Environmental Protection Act (NEPA) Compliance
25	Task 3	1.2.5	Develop Interoperability and Cyber Security Plan
30	Task 4	1.2.6	Develop Metrics and Benefits Reporting Plan
36	Task 5.A	1.2.7	Engineering for this Specific Application at PMPP
113	Task 5.C	1.2.9	Technology Transfer and Scale Up
161		1.2.10	Phase II Release
162		1.6	Phase II Final Design and Construction
163		1.6.1	10 kW Stack Go/No Go Decision
164	Task 5.D	1.6.14	Battery 1 Fabrication, Installation and Testing (540KW)
241	Task 5.E	1.6.3	Facility Construction and Preparation
249		1.6.4	30kW Go/No Go Decision
250	Task 5.F	1.6.5	Battery 2 Fabrication, Installation and Testing (540KW and 1.08MW)
287	Task 5.G	1.6.6	Release Final Operating and Maintenance Procedures
288		1.4	Phase III Commissioning and Operations
289		1.4.1	Go/NO GO Decision for Data Collection and Monitoring
290	Task 6	1.4.2	Data Collection and Monitoring
293		1.4.3	Release Final Data Collection Information to Publishing
294		1.5	Deliverables

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Progress To Date

- Recent work released
  - Prototype battery stack fabrication
  - Battery process system & test bed design
  - Preliminary building design
  - New membrane
  - Improved flow frame design
- Full contract definitization expected end October

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Summary/Conclusions

- Project is essentially on schedule and on budget
- Test bed confirmation of higher molar electrolyte is key to storage time target
- Test bed confirmation of process design changes will demonstrate round trip efficiency improvements

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Future Tasks

- Battery process system & test bed installation
- Electrolyte Production
- Prototype Testing
- Inverter Design Modifications

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