DEMONSTRATION OF MULTI-GAMMA BASED SENSOR TECHNOLOGY FOR AS-FIRED COAL PROPERTY MANAGEMENT
(Award No. DE-FE00031750)

2020 Annual Project Review Meeting

Project Team:

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David Stadem
James Langfeld
Steve Benson
Microbeam Technologies Inc.

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Devon Morgan
Energy Technologies Inc.

Travis Desell
AbdElRahman El-Said
Zimeng Lyu
Rochester Institute of Technology

11/6/20

Acknowledgement – DOE NETL
Jessica Mullen – DOE NETL Project Manager
Presentation Overview

- **Project Information**
  - Project Team
  - Project Goal and Objectives
  - Project Structure and Schedule

- **Accomplishments**
  - MGA Sensor Lab Testing
  - Accumulation and Analysis Of Attenuation Signals
  - On-site Sensor Installation
  - MGA Data Acquisition and Processing System

- **Next Steps**
Project Team

- **Technical Team:**
  - Microbeam Technologies Inc.
  - Energy Technologies Inc.
  - Rochester Institute of Technology
    - Department of Software Engineering

- **Funding Support:**
  - U.S. Department of Energy, National Energy Technology Laboratory
  - Otter Tail Power’s Coyote Station
  - Energy Technologies Inc.
  - Rochester Institute of Technology

- **Project Support:**
  - Minnkota Power’s Milton R. Young Station
  - North American Coal Company
Project Goal

The overall goal of this project is to demonstrate the application of the use of an advanced multigamma attenuation (MGA) sensor to accurately and precisely measure coal properties at the point of injection into burners.
Objectives

- Test MGA sensors on a range of selected coal samples at ETI laboratories
- Accumulate and analyze attenuation signal information
- Develop relationships for coal quality parameters with statistical and neural network analysis
- Install MGA sensors on-site and develop MGA output database
- Develop MGA-FSEA correlations with neural networks and install MGA data augmented CSPI-CT on-site
- Conduct a field test to validate augmented CSPI-CT findings
- Install a validated version of CSPI-CT on-site
Project Structure and Roles of Participants

Microbeam President
Dr. Steven A. Benson

Microbeam Financial Officer
Ms. Roxanne B. Benson

US DOE
National Energy Technology Laboratory

Principal Investigator
Ms. Shuchita Patwardhan

Project Co-Sponsors
Otter Tail Power Co.
Energy Technologies Inc.
Rochester Institute of Technology

Task 1. Project Management and Reporting
MTI
Shuchita Patwardhan
Steven Benson

Task 2. Factory Testing of MGA Sensors
ETI
David Swindell
Devon Morgan
MTI
Shuchita Patwardhan
David Stadem

Task 3. Installation of MGA at Coyote Station
ETI
David Swindell
Devon Morgan
MTI
David Stadem
OIP
Maverick Thompson
RIT
Travis Desell

Task 4. MGA Database and Correlations Development
ETI
Devon Morgan
MTI
David Stadem
Matt Fuka
OIP
Maverick Thompson
RIT
Travis Desell

Task 5. Field Testing MGA
MTI
Shuchita Patwardhan
David Stadem
Matt Fuka
ETI
Devon Morgan
OIP
Maverick Thompson
RIT
Travis Desell

Task 6. Integrate with C SPI-CT
MTI
Shuchita Patwardhan
David Stadem
Matt Fuka
ETI
Devon Morgan
OIP
Maverick Thompson
RIT
Travis Desell
# Schedule

## Task Dates

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<tr>
<th>Task Dates</th>
<th>Start Date</th>
<th>End Date</th>
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<td>Task 1 - Project Management &amp; Reporting</td>
<td>10/1/2019</td>
<td>9/30/2022</td>
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<td>Task 2 - Factory testing of MGA Sensors</td>
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<td>Task 4. MGA Database and Correlations Development</td>
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<td>Task 6. Integrate with CSPI-CT</td>
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## Total Project Length – 36 Months

- **Budget Period 1** – 10/1/2019 – 3/31/2021
- **Budget Period 2** – 4/1/2021 – 9/30/2022
Testing Site

Primary site: Otter Tail Power’s Coyote Station

- Cyclone Fired Boiler
- MW – 450
- Fuel – ND Lignite
- Daily fuel delivery – 7000 - 12000 tons of coal – 2.5 million tons of lignite annual consumption – Mine mouth plant
Technology

- On-line analyzer adapted for analysis of coal flowing through feed pipes to burners that utilizes multi-energy gamma attenuation measurements of fuel properties that include heating value, ash content, and selected ash-forming components.
- System calibrated to different inorganic components through machine learning that contribute to the total ash composition.
- The core of the technology is a multi-energy gamma attenuation (MGA) source.
- This source improves the accuracy and precision of measuring the ash-forming materials for full-stream fuel delivery applications.
OtterTail Power’s Coyote Station’s Coal Handling System

Multi-Gamma Attenuation Sensor
Task Structure

Task 1 - Project Management and Reporting

Task 2 - Factory Testing of MGA Sensors

Task 3 - Installation of MGA at Power Plant

Task 4 - MGA Database and Correlations Development

Task 5 - MGA Field Test

Task 6 - Integrate with CSPI-CT
Task 1
Project Management and Reporting

- Kick-off Meeting
- Project Management Plan
- Monthly Meetings
- Quarterly Reports
- MGA Factory Test Report
- Workforce Readiness Plan
- Field Test Report
- Commercialization Plan
Task 1 Updates

- Monthly reports to DOE
- 4 quarterly reports submitted to DOE
- Factory acceptance test report submitted on 5/31/2020
- MGA Sensor Installation – delayed due to COVID-19
Task 2
Factory Testing of MGA Sensors

- Subtask 2.1 – MGA Setup in ETI Laboratories
- Subtask 2.2 – Identification of a range of lignite/test samples
- Subtask 2.3 – Accumulation of attenuation signals
- Subtask 2.4 – Analyze attenuation information
- Subtask 2.5 – Develop relationships/fingerprints for coal quality parameters
Factory Testing Setup
MGA Source Beam
Lab Testing

- Empty pipe testing
- Coal placement optimization
- Coal thickness optimization
- Data acquisition time
- Fine tuning of data acquisition system
Test Matrix

- Coal composition database was developed
- Twenty-six coal samples selected for testing
  - Ten lignite coals
  - Nine sub-bituminous coals
  - 6 bituminous coals
  - One coal of un-identified rank
Lab Testing

- 110 Runs Complete
  - 26 coal sample runs
  - 79 runs with spiking elements
  - 3 runs with clay minerals
  - 3 runs with different petri-dish placement
Task 3
Installation of MGA at Coyote Station

- Subtask 3.1 Design of MGA Sensor Frame and housing
- Subtask 3.2 Identification of installation locations and install
- Subtask 3.3 Set up data compilation system
Coyote Feeder Pipe – Sensor Installation – Aug 2020

- Sensors will be upgraded in 2021.
Field Test

- Collected 26 coal samples, 13 slag samples and 13 fly ash samples
- Plant operations – full load with relatively steady operation.
- Working on sample analysis.

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MGA Data Acquisition and Processing System
## Milestone

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*Delayed due to Covid-19.*
Questions?

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