NLGC National Laboratory Gasification Consortium

Introductory Webinar

August 21st, 2025

U.S. DEPARTMENT of ENERGY | Office of Fossil Energy and Carbon Management

NATIONAL ENERGY TECHNOLOGY LABORATORY

Idaho National Laboratory

OAK RIDGE National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

NLGC Introductory Webinar

NLGC National Laboratory Gasification Consortium

Welcome!

Logistics

- A recording of the Webinar and the presentation slides will be available within 24 hours at the USEA website
- Feel free to submit comments or feedback through the Chat feature
  - We may not have time to answer questions today, but will review your feedback

Agenda:

- Introduction and NLGC Background
- Online Participant Polling
- NLGC Organization
- Reviews of Technical Tasks
- Summary
- Introduction to the Industry Data Survey

USEA and Speaker Introductions

NLGC
National Laboratory Gasification Consortium

Dr. Nathan T. Weiland
Senior Fellow – Energy Conversion Engineering
National Energy Technology Laboratory

Dr. Edward J. Wolfrum
Principal Researcher and Group Manager
National Renewable Energy Laboratory

Michael Talmadge
Senior Research Engineer
National Renewable Energy Laboratory

Dr. Jordan L. Klinger
Senior Research Engineer
Idaho National Laboratory

Dr. James E. Parks II
Section Head, Energy and Industrial Processes Section
Oak Ridge National Laboratory

Dr. Mehrdad Shahnam
Team Supervisor, Computational Multiphase Flow Science Team, National Energy Technology Laboratory

NLGC Snapshot

Boilerplate Information

- **DOE:** Office of Fossil Energy
- **Program**: Advanced Energy Systems
  - **Division Director**: Bob Schrecengost
- **Subprogram**: Gasification
  - **Program Manager**: Jai-Woh Kim
  - **NETL Technology Manager**: Jonathan Lekse
- **NLGC Lead**: Nate Weiland (NETL)
- **NLGC Co-Principal Investigators**: Jordan Klinger (INL), Jim Parks (ORNL), Mehrdad Shahnam (NETL), Mike Talmadge (NREL), Ed Wolfrum (NREL)
- **Federal Project Manager**: Mike Bergen (NETL)
- **Period of Performance**: 4/1/2025 – 3/31/2029 (4 years)
- **Year 1 Budget**: $5.38M

NLGC Background

- Gasification converts carbonaceous solid feedstocks into syngas to enable the low-cost production of hydrogen, transportation fuels, chemicals, electricity, and other products
- FECM's Gasification Program has funded individual gasification R&D Field Work Proposals (FWPs) from INL, NETL, NREL, and ORNL, which were combined into a consortium in FY25
  - NETL's RIC asked to lead the consortium due to our role as a Government-Owned, Government Operated lab and intimate knowledge of FECM's needs
- Benefits
  - Coordinated Gasification R&D that optimally utilizes the strengths of each participating national laboratory
  - Improved communication and coordination of national laboratories' activities in Gasification
  - Achievement of broader program goals than any one lab can attain alone
- The NLGC is advancing prior BETO-funded work and relationships begun under:

The NLGC Builds on Gasification Experience at NLs

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Biomass Feedstock National User Facility

Idaho National Laboratory

"Billion Ton" Resource Study

OAK RIDGE National Laboratory

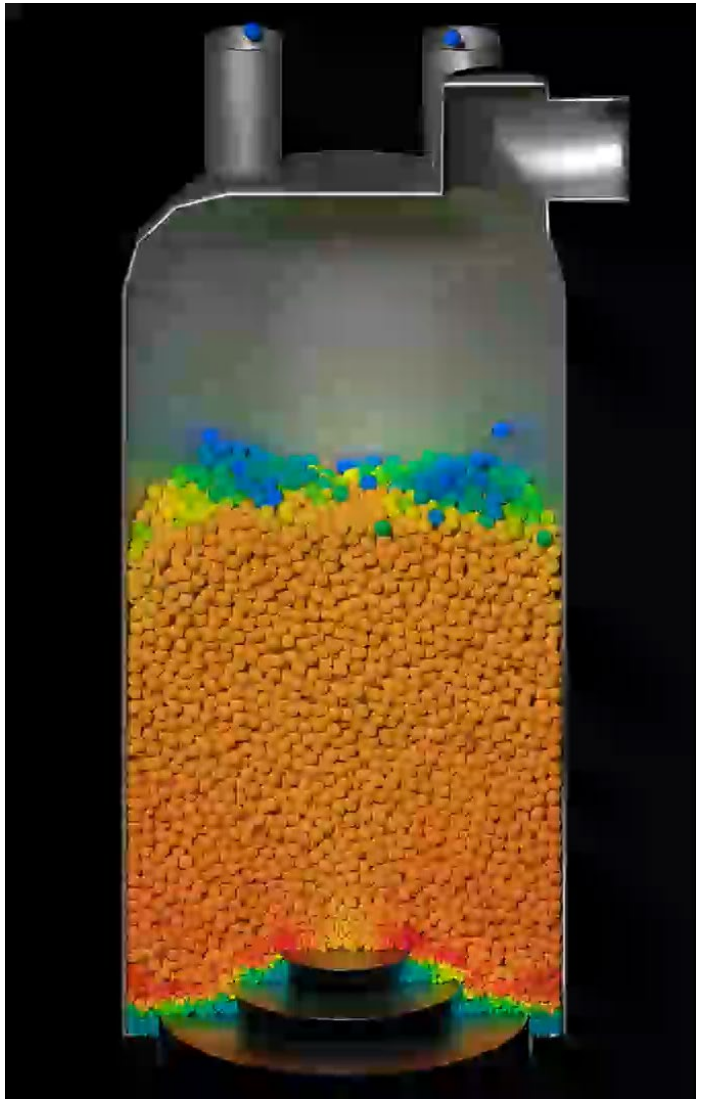
MFiX Computational Fluid Dynamic Gasifier Modeling

MFiX

Feedstock and Product Chemistry

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NATIONAL ENERGY TECHNOLOGY LABORATORY



NLGC Timeline

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Individual Lab work in Gasification

Before 2024

Delivered Final Work Plans to FECM

Feb. 1, 2025

NLGC Introductory Webinar

August 21, 2025

U.S. DEPARTMENT of ENERGY
Office of Fossil Energy and Carbon Management

fcic
FEEDSTOCK-CONVERSION INTERFACE CONSORTIUM
U.S. DEPARTMENT OF ENERGY

CCPC
Consortium for Computational Physics and Chemistry
U.S. DEPARTMENT OF ENERGY
BIOENERGY TECHNOLOGIES OFFICE

Consortium Planning Kickoff Meeting

June 5, 2024

NLGC

NLGC Kickoff Meeting with FECM

April 29, 2025

Online Poll for Participants

Please reply on behalf of your organization or business unit

Anonymous Menti poll to provide real-time results on participants':

- Organization
- Feedstock interests
- Reactor types and reactants of interest
- Scales of operation
- Co-gasification challenges

How to participate-

- Click QR code on your phone (next slide)
- Click link in the chat
- Go to menti.com – enter the code (next slide)

Crosscutting Gasification Challenges

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Based on recent Workshops and Requests For Information

- Analysis tools to assess waste resource availability, cost, and environmental impact, to enable economically viable gasification projects to be optimally sited
- Technical and economic tradeoff assessments between feedstock preprocessing, gasifier selection, and syngas cleanup
- Cost-effective in-situ feedstock variability measurements to enable gasifier operational optimization
- Waste feedstock resource variability assessments to inform gasification plant designs and operability
- Specific preprocessing requirements for biomass, plastics, and Municipal Solid Waste (MSW) to mitigate impacts from the high amounts of alkali metals, tar, chlorine/halogens, and unusual contaminants
- Gasification reaction kinetics R&D for alternative feedstocks to enable computational tools for gasifier plant design, scaleup, and digital twinning

NLGC Goals & Objectives

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Goal: To enable economic utilization of a broader spectrum of alternative and blended feedstocks to ensure fuel resiliency in gasification systems

Objectives:

- Engage industry to collaboratively tackle gasification feedstock challenges by leveraging the national labs' premier capabilities
- Expand the gasification feedstock base to include waste resources and mixtures of these with coal and biomass to produce syngas for energy, chemicals, fuels, and/or hydrogen
- Provide data, information and tools to expand alternative and blended feedstock utilization in the gasification industry

NLGC Overview

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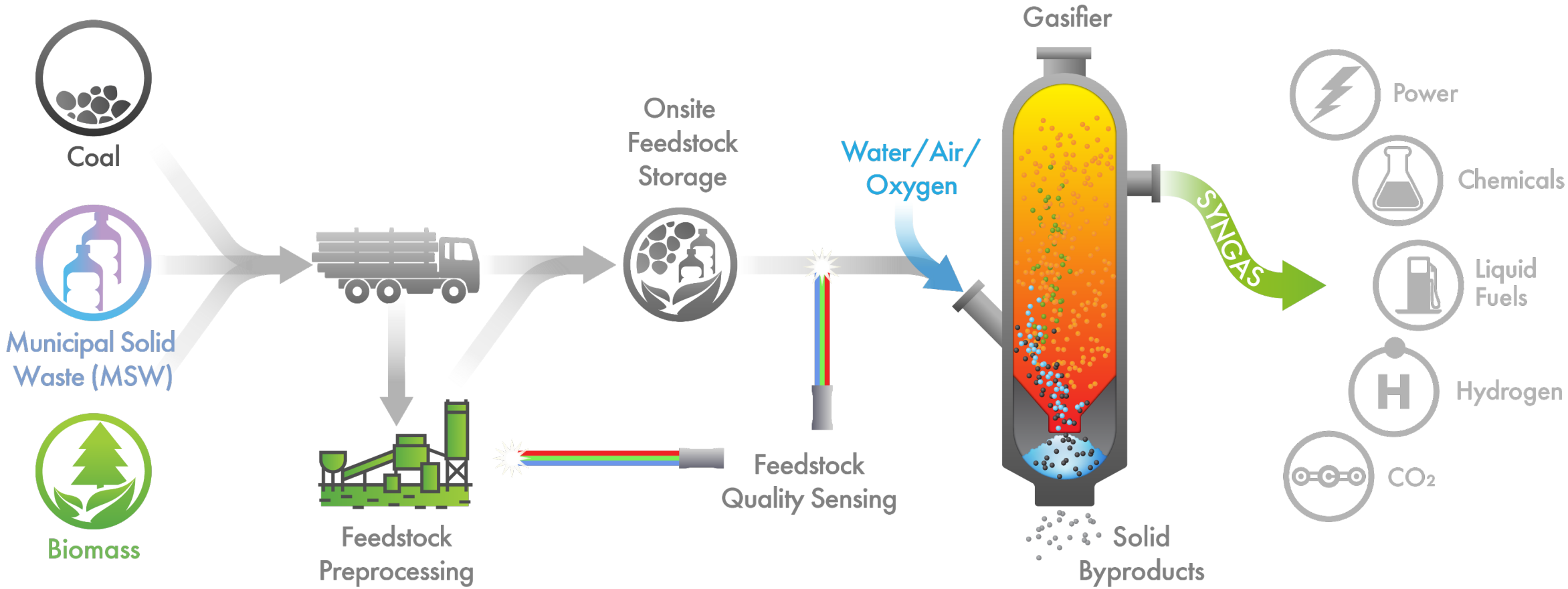
Gasification Consortium



NLGC Organization

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Task Structure and Leads

	Task Lead
Task 1: FWP Coordination	**Nate Weiland*** NETL
Task 2: Supply-Chain Modeling and Analysis	**Mike Talmadge** NREL
Task 3: Upstream Feedstock Quality and Preprocessing	**Jordan Klinger*** INL
Task 4: Feedstock Variability, Sensing & Control	**Jim Parks*** ORNL
Task 5: Pyrolysis and Gasification Kinetics Database and ML Tool	**Mehrdad Shahnam** NETL

***Lab Lead**

Ed Wolfrum* - NREL

NLGC Overview

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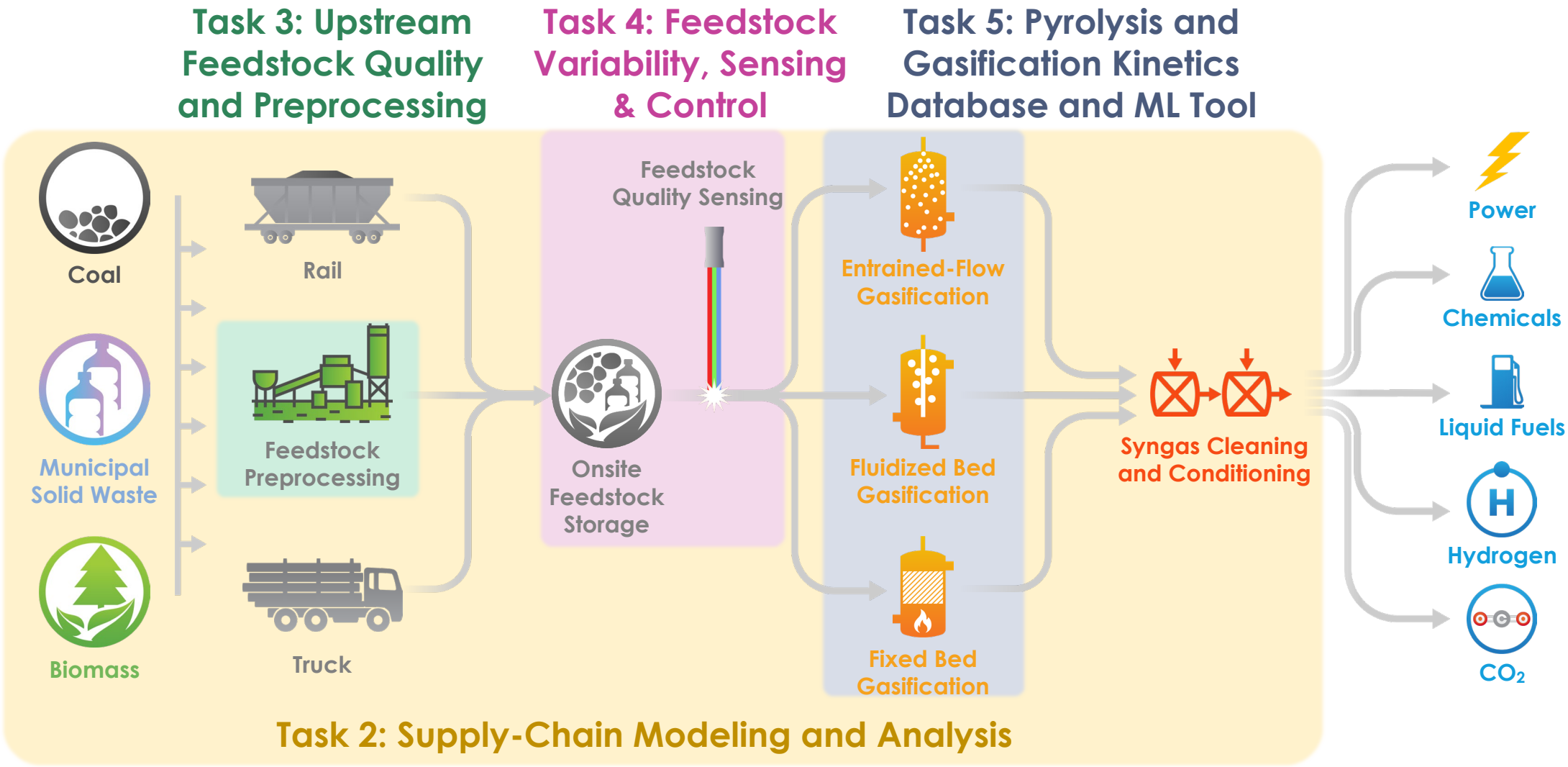
Task Level Scope



NLGC Management

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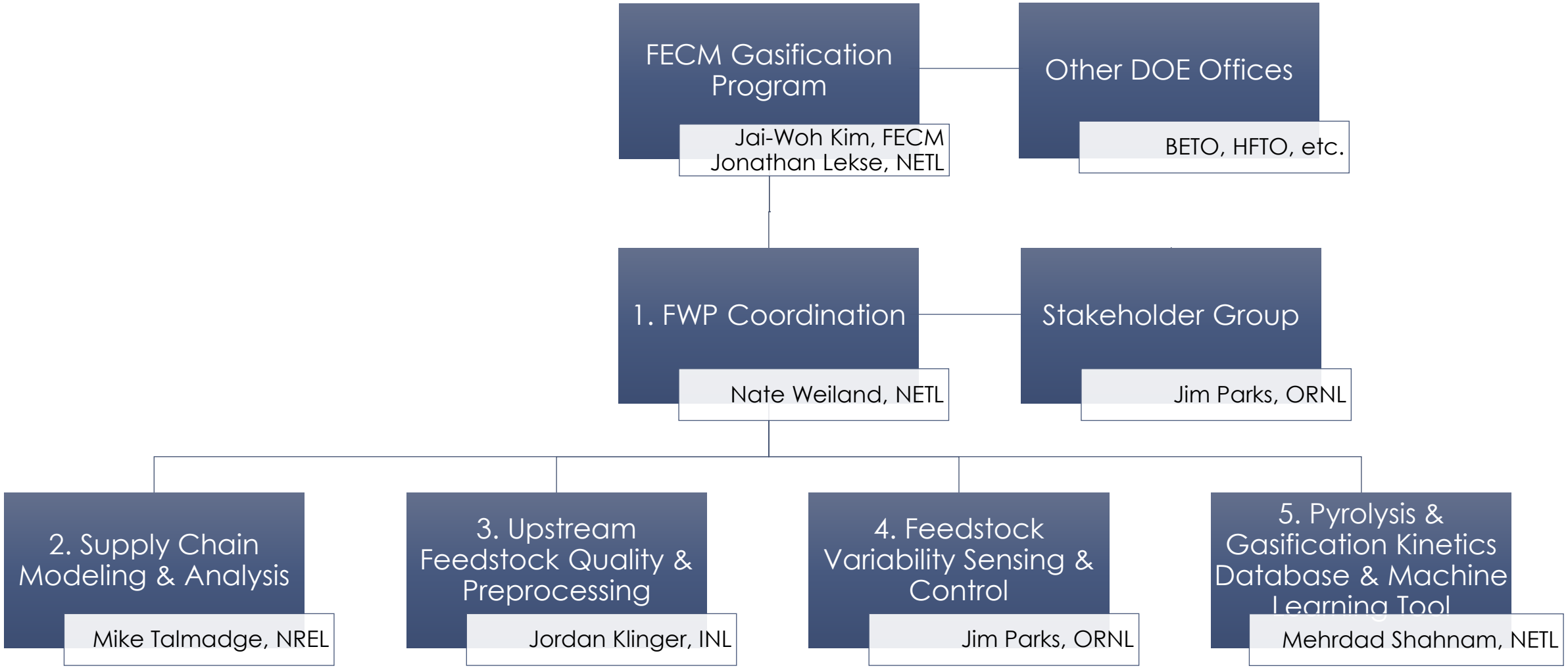
Organizational chart



Federal Work Plan (FWP) Coordination

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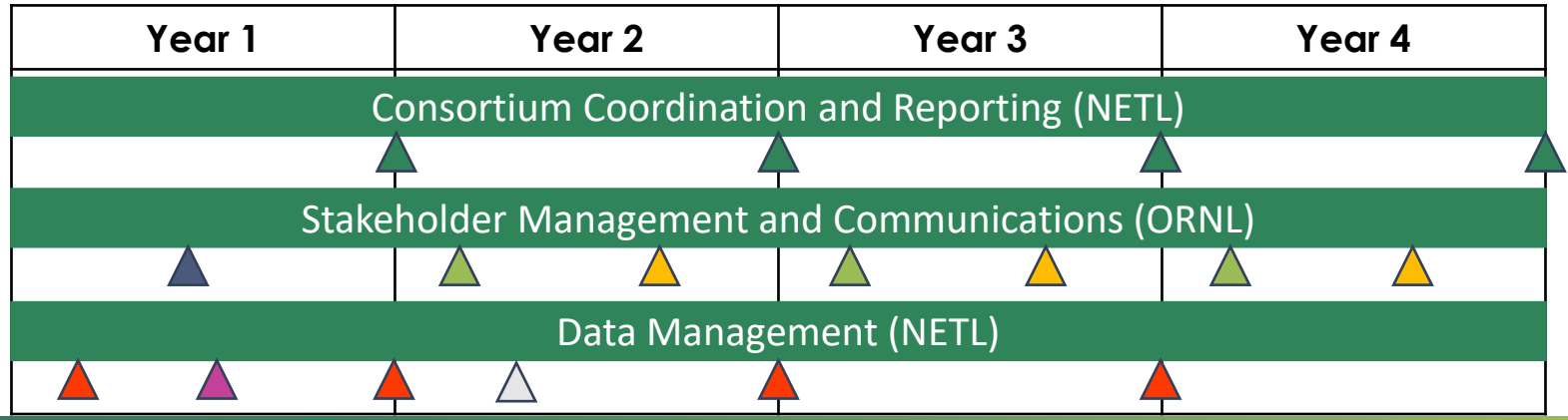
Goals, Objectives, and Activities

Goal: Coordinate national lab R&D to meet the FECM Gasification Program's goals.

Objectives: Develop impactful joint R&D scope, facilitate communications with FECM and gasification stakeholders, and manage gasification data for internal and external use.

Lead: Nate Weiland (NETL), Technical Task Leads (All Labs)

- Consortium Coordination and Reporting (NETL)
  - Annual Reports
- Stakeholder Management and Communications (ORNL)
  - NLGC Introductory Webinar – August 21st, 2025
  - Presentation at Spring Project Review Meetings
  - Fall virtual meetings
- Data Management (NETL)
  - Data needs assessments & coordination
  - Data Management Plan
  - EDX data repository for public use



NLGC Coordination

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Stakeholder Interactions

- Plans for bi-annual public meetings
- In-person NLGC Stakeholder Workshop to present on our progress and obtain feedback from industry
  - To be held during the FECM / NETL Carbon Management Research Project Review Meeting, Pittsburgh, PA, June 2026
- Virtual NLGC Webinar/Workshop ~ January 2026

Data Management

- EDX repository for data:
  - A secure, **private** EDX site will be developed for use in sharing data within the consortium
  - A secure, **public** EDX site and NLGC website will be developed by June 2026
- Bioenergy Feedstock Library:
  - As new feedstock blends are developed and analyzed under Task 3 of the consortium, INL's Bioenergy Feedstock Library will be updated with this information

EDX INSIGHT$_2$T

Biomass Feedstock National User Facility
Bioenergy Feedstock Library

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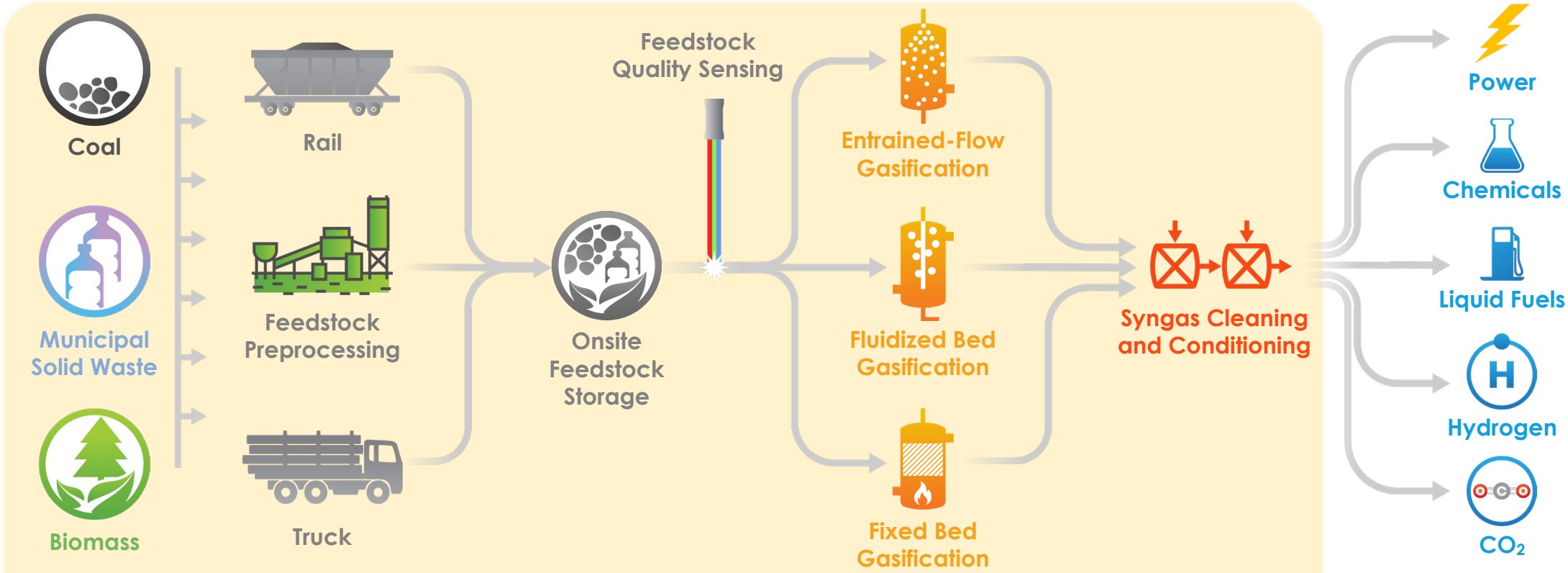
Task Level Scope



Task 2: Supply-Chain Modeling and Analysis

Supply-Chain Modeling and Analysis

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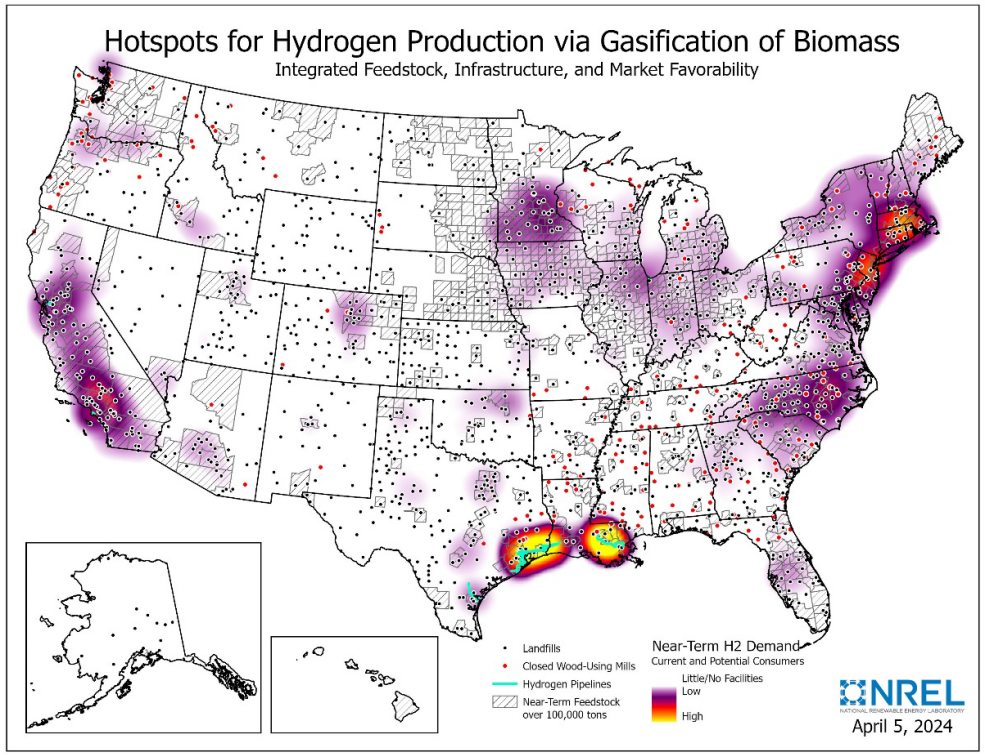
Goals:

- Evaluate **cost and emissions minimization** for H_2 produced from waste resources.
- Identify **promising locations for technology deployment**.
- Publish **useful tools to support industry development**.

Scope:

- Integrate resource assessments, feedstock sorting and pre-processing models, gasification process models, TEA, geospatial facility siting analysis, and process design.
  - Comprehensive **resource** data set for MSW, herbaceous, coal
  - Optimized advanced **sorting and preprocessing** strategies
  - Process models for **gasification** technologies and **syngas cleanup**
  - **Market considerations** for feedstocks and products
  - Analysis framework to assess **waste-to-syngas supply chain**
  - **Publish tools** for GIS-based **facility siting and process design**



Supply-Chain Modeling and Analysis Team

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* Indicates sub-task lead

Mike Talmadge
NREL*

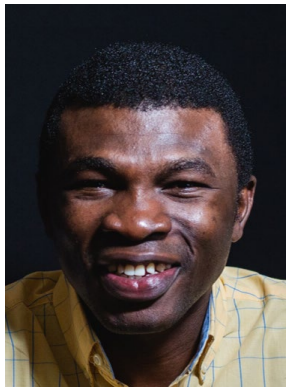
Eric Lewis
NETL*

Bob Wallace
NETL*

Tammy Lin
INL*

Gary Grim
NREL*

Anelia Milbrandt
NREL



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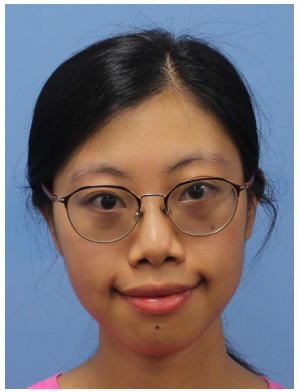
Bob Stevens
NETL

Gavin Pickenpaugh
NETL



Gui Zheng
NREL

Supply-Chain Modeling and Analysis Overview

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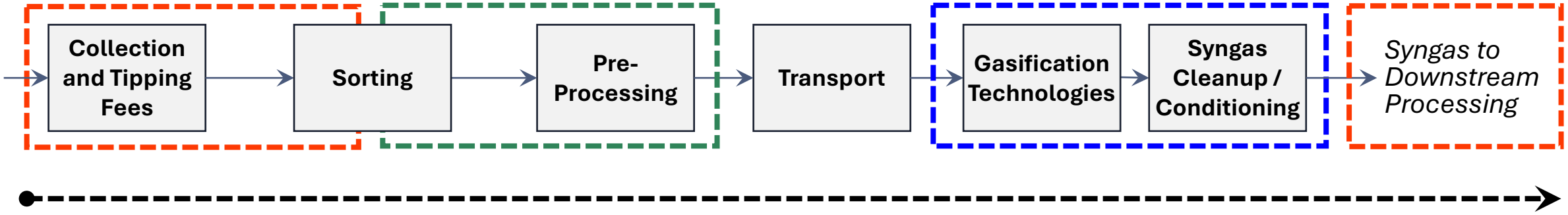
Feedstocks, Markets, & Facility Siting: GIS-based analysis for feedstock sourcing, market opportunities, and facility siting

Feedstock Sorting & Preprocessing: Feedstock preprocessing analysis with considerations for the trade-offs between preprocessing cost and emissions vs. downstream benefits

Gasification Process Modeling: Process modeling and analysis based on NETL and NREL models for different feedstock-gasifier technology combinations



Data Coordination: Data gap assessments and tracking for supply chain modeling basis

Resource to End-Use TEA/LCA: Develop analysis framework to quantify cost and emissions from waste resource to syngas

Design Handbook: Develop waste gasifier design handbook for public dissemination

Feedstocks, Markets, and Facility Siting

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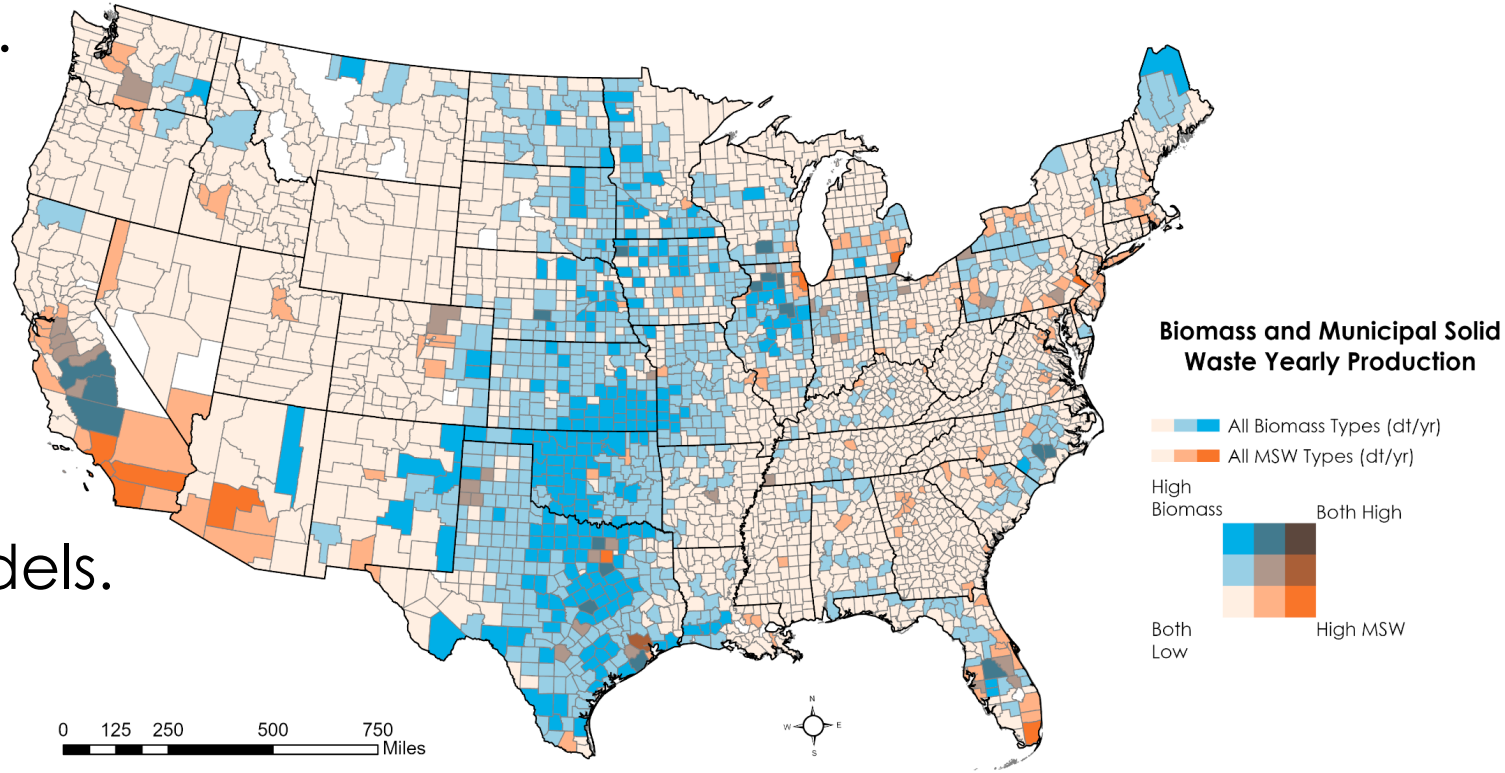
- Integrate **data sets for waste biomass, coal, and mixed MSW**.
- Apply **GIS-based analysis** for wastes, infrastructure, markets, and facility siting.
- Connect resource data with **sorting and pre-processing** models.
- Develop and publish **tool for economic analysis and facility siting** evaluations.



Source: USDOE Billion Ton Study

Resource Sorting and Preprocessing

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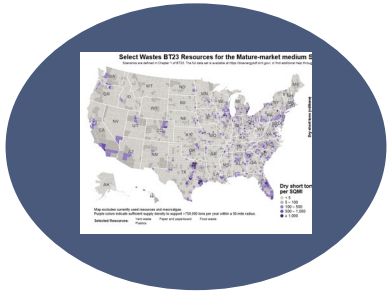
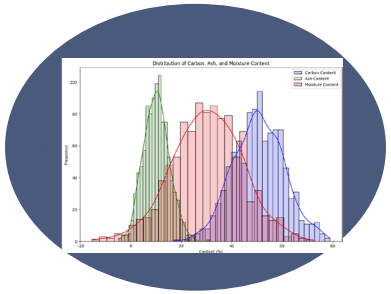
Resource Availability



Resource Quality



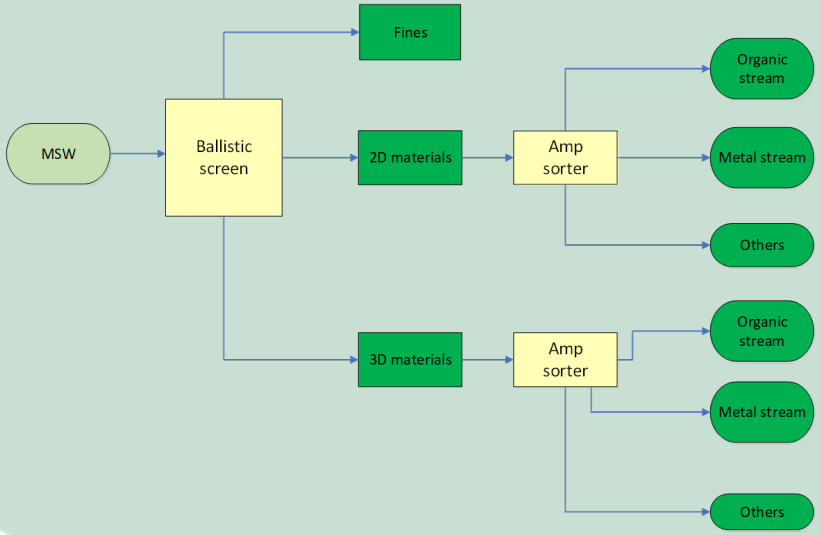
Quality Specifications

Ash content
Moisture content
Volatile matter
Carbon content
PSD

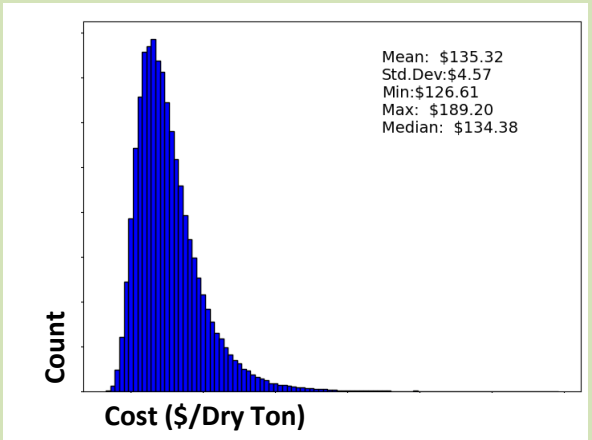
Preprocessing Technologies

- **Sorting and Separation:** Manual hand sorting; Magnetic separator; Eddy current separator; Froth floatation
- **Size Reduction:** Sieving; Milling; Chipping; Grinding; Cutting
- **Moisture Content:** Drying; Solvent Based; Filtration; Centrifugation
- **Density:** Torrefaction, Pelletization
- **Contaminants Removal:** Washing; Air classification; Dimethyl Ether (DME)

Configurations for Different Resources



Cost and Emissions Estimates from Modeled Configurations



Gasification Process Modeling

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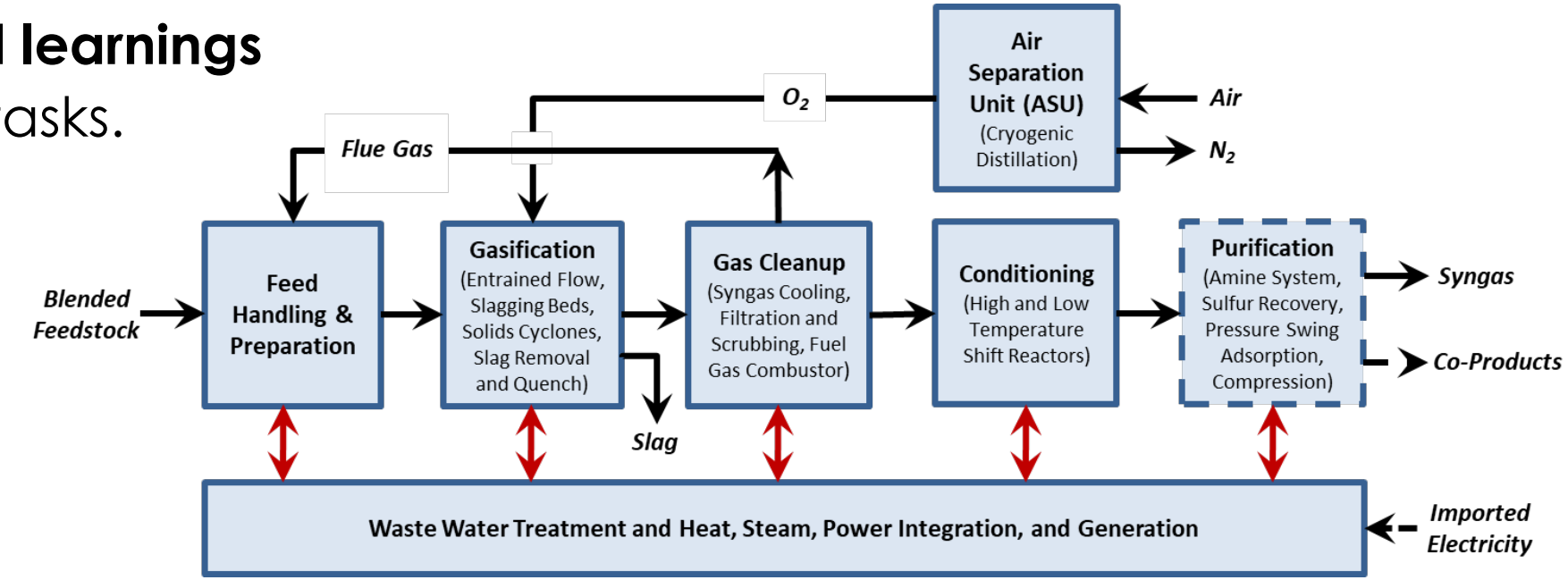
- Apply **process models and TEA/LCA** to estimate yields, conversion costs, and emissions.
- **Integrate** outputs from **pre-processing models** as gasifier feedstocks.
- Provide **flexible models** to assess different gasifiers and syngas quality targets.
- Incorporate **data and learnings from NLGC research** tasks.
- Provide conversion basis for **supply chain analysis** framework.



Integrated Analysis Framework

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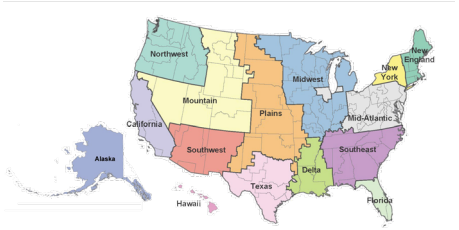
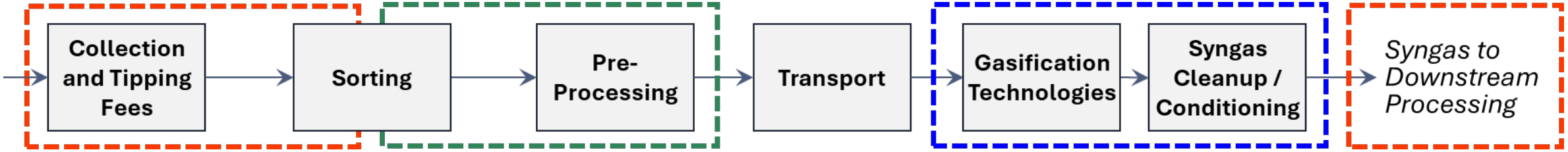
Develop framework to assess and optimize supply-chain economic and sustainability metrics.





Explore supply chain variable impact on cost and emissions through scenario analysis.

- *Gasification plant scale vs. feedstock collection radius and transportation distance.*
- *Tradeoffs between co-location with resource (e.g., landfill) vs. syngas consumer (e.g., refinery).*
- *Scenarios and specific locations that minimize cost and/or emissions.*
- *Impacts of different feedstock sources and blends on scale, yields, reliability, costs, and emissions.*
- *Limitations and opportunities based on different gasifier technologies.*

Economic and Facility Siting Assessment Tool

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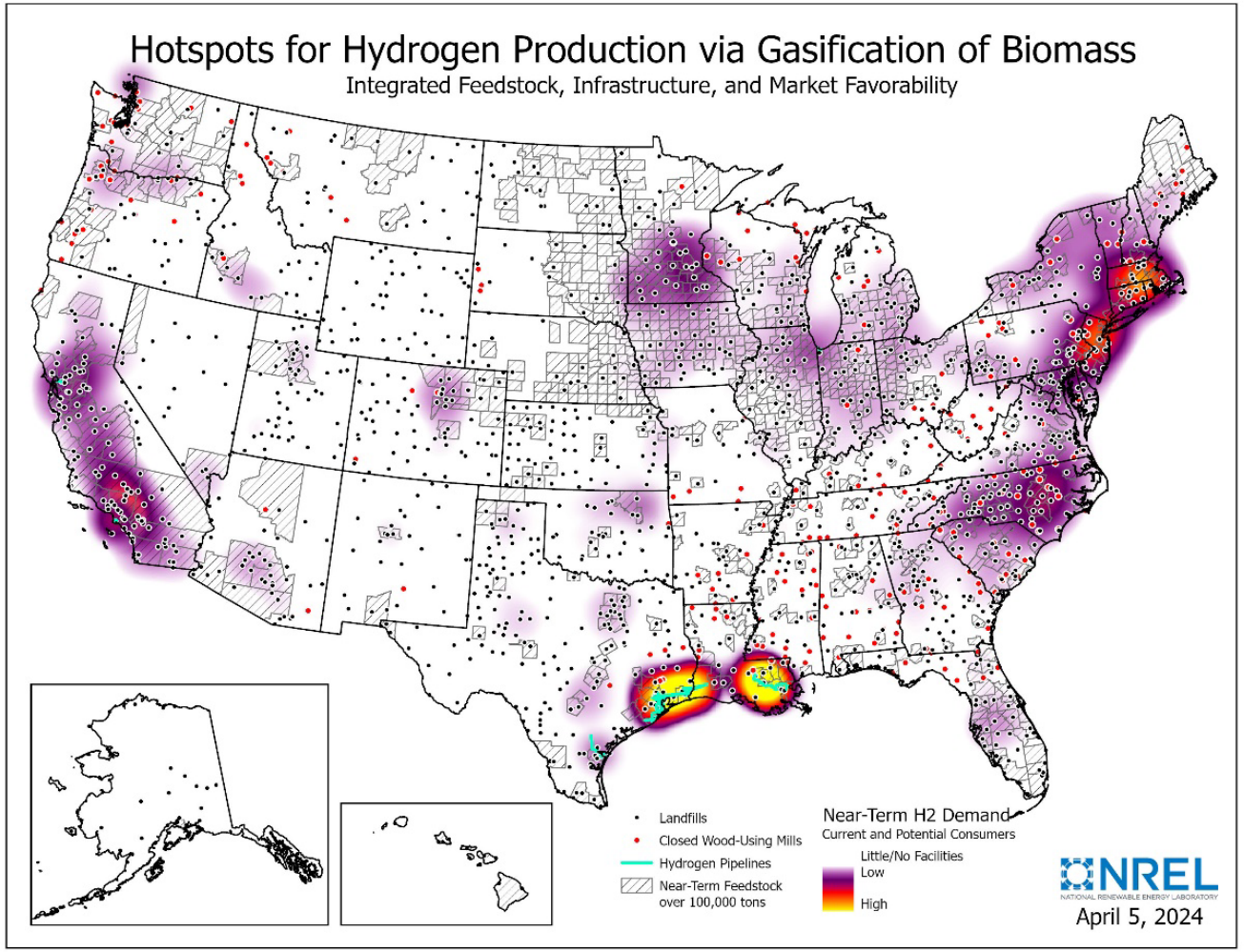
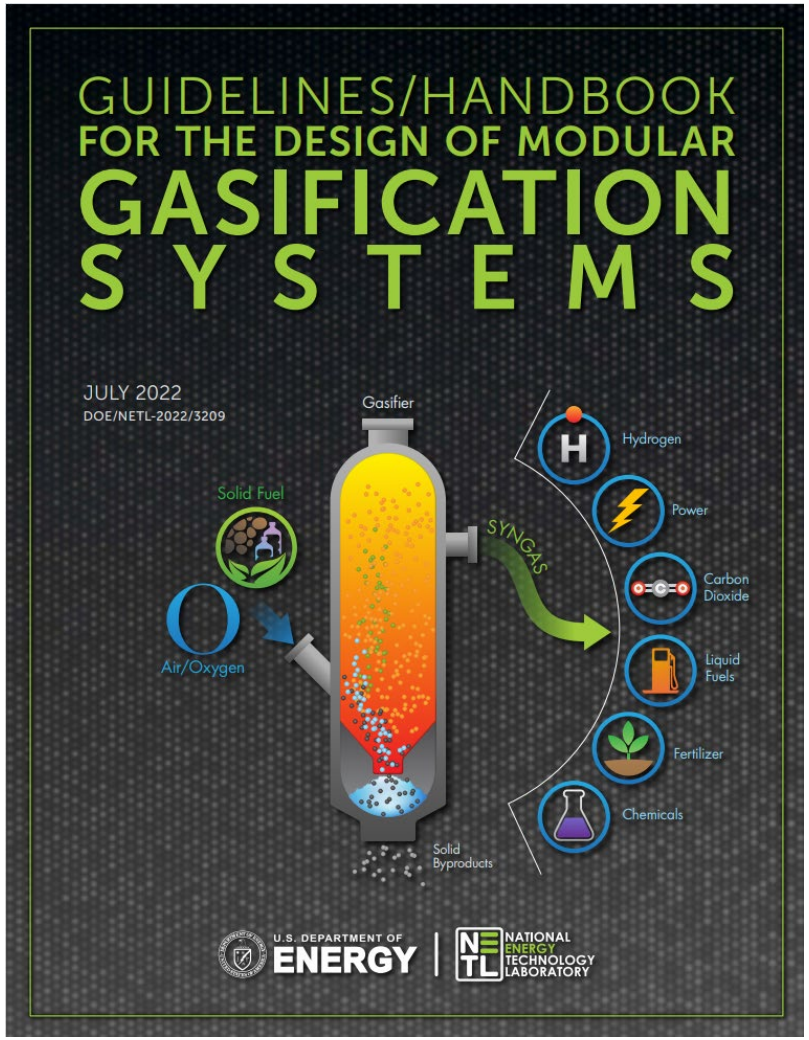
- Combine data and models for resources, feedstock sorting and preprocessing, transportation, conversion technologies, and product utilization.
- Publish analysis and siting tool based on user inputs.
- Promote commercialization by enabling screening analysis capabilities to stakeholders.



Design Handbook

- Incorporate learnings of alternative feedstock gasification supply chain systems into the NETL Gasification Systems Handbook
- Select sections from the current handbook that may be updated include:
  - Scope definition
  - Guidelines for the design of a Gasification Module
  - Guidelines for the design of a Feedstock Handling and Pretreatment Module
  - Guidelines for the Design of a Syngas Cleanup and/or Conversion Module



https://www.netl.doe.gov/sites/default/files/2022-07/Gasification%20Handbook.pdf

Data Coordination and Industry Engagement

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- Data Coordination tracks major gaps in data and models for analysis.
- High priority aspects of data needs for industry input:
  - MSW resource scenarios
    - Source-separated materials to clean MRF
    - Mixed MSW to dirty MRF)
  - Feedstock formats (chipped, pelletized, pulverized)
  - Gasifier technologies (fluidized bed, entrained flow)
  - Limits for mixing feedstock types (biomass, coal, MSW-derived materials)
  - Characteristics and capabilities of public-facing tool
  - Scenarios for analysis
    - Co-location with existing infrastructure
    - Optimizations between scale and transport
  - Impact of feed contaminants on syngas clean-up steps and reliability concerns

NLGC Overview

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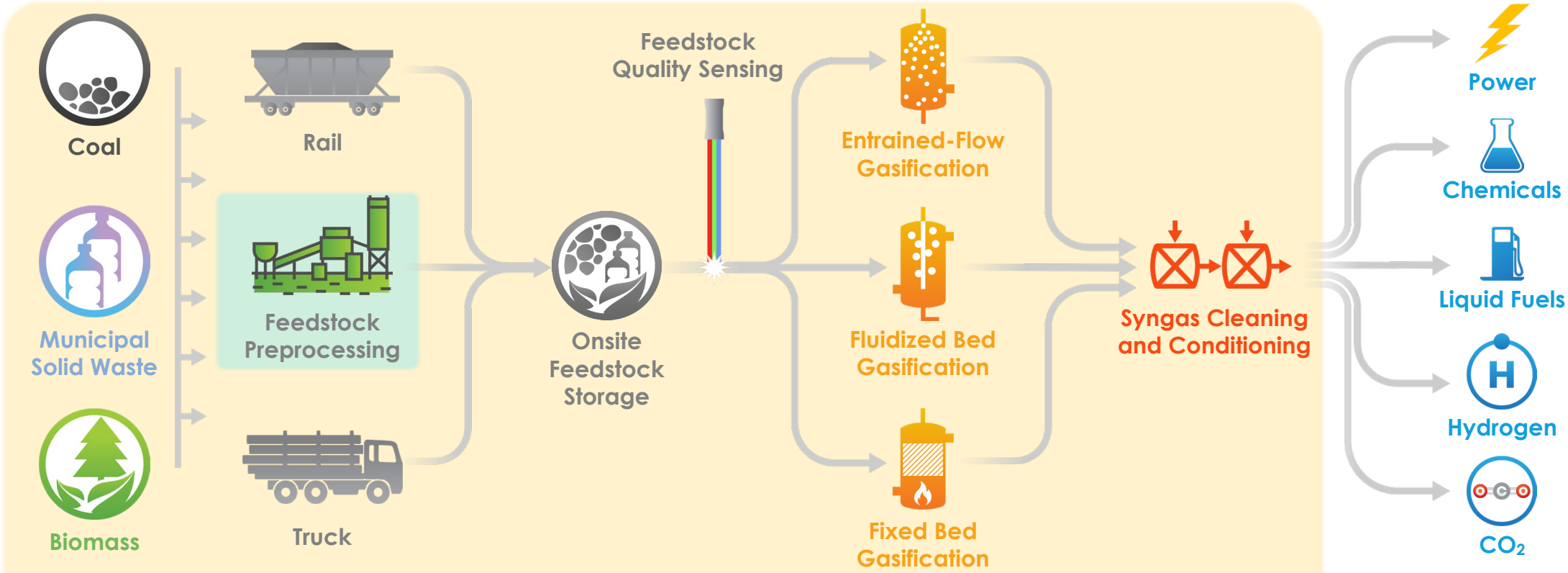
Task Level Scope

Task 3: Upstream Feedstock Quality and Preprocessing



Task 2: Supply-Chain Modeling and Analysis

Upstream Feedstock Quality and Preprocessing

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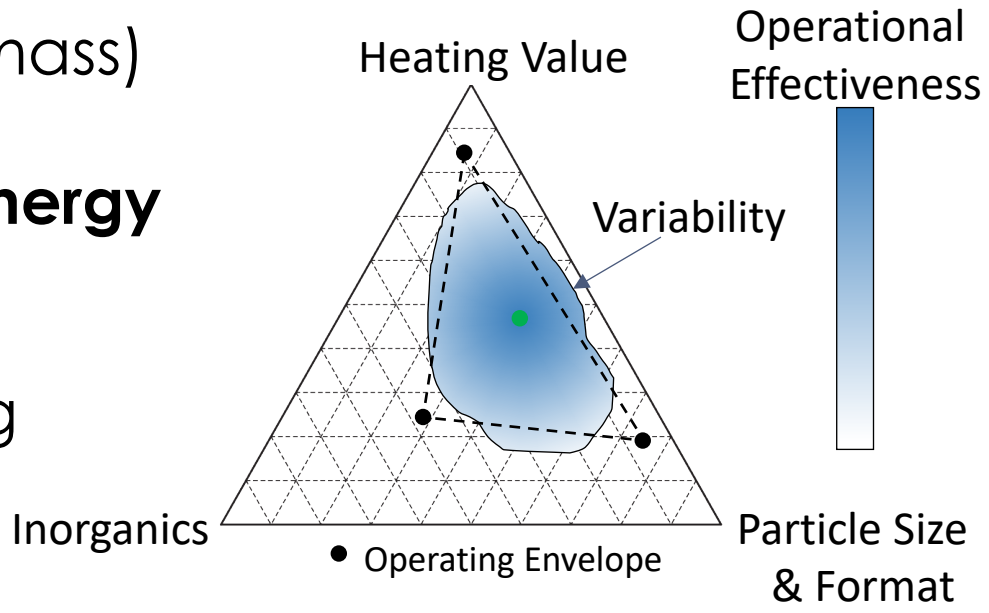
Goal

- Convert coal and waste resources (MSW, biomass) into conversion-ready feedstocks and quantify the economic & energy impacts of preprocessing

Objectives

- **Identify optimal preprocessing pathways** to convert coal and waste materials (MSW, biomass) into conversion-ready feedstocks
- Produce validation data such as **mass and energy balances for preprocessing pathways** for predictive tools to estimate cost tradeoffs
- **Establish relationships** between preprocessing intensity and feedstock quality



Task 3 Team

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Gasification Consortium

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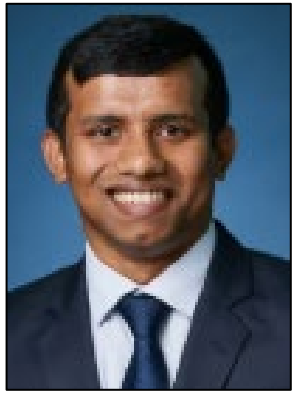
Rachel Emerson, INL



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Ed Wolfrum, NREL

Zophia Tillman, NREL

Charles Finney, ORNL

Ben Chorpening, NETL

Dan Hartzler, NETL

Neal Yancey, INL

Upstream Feedstock Quality and Preprocessing

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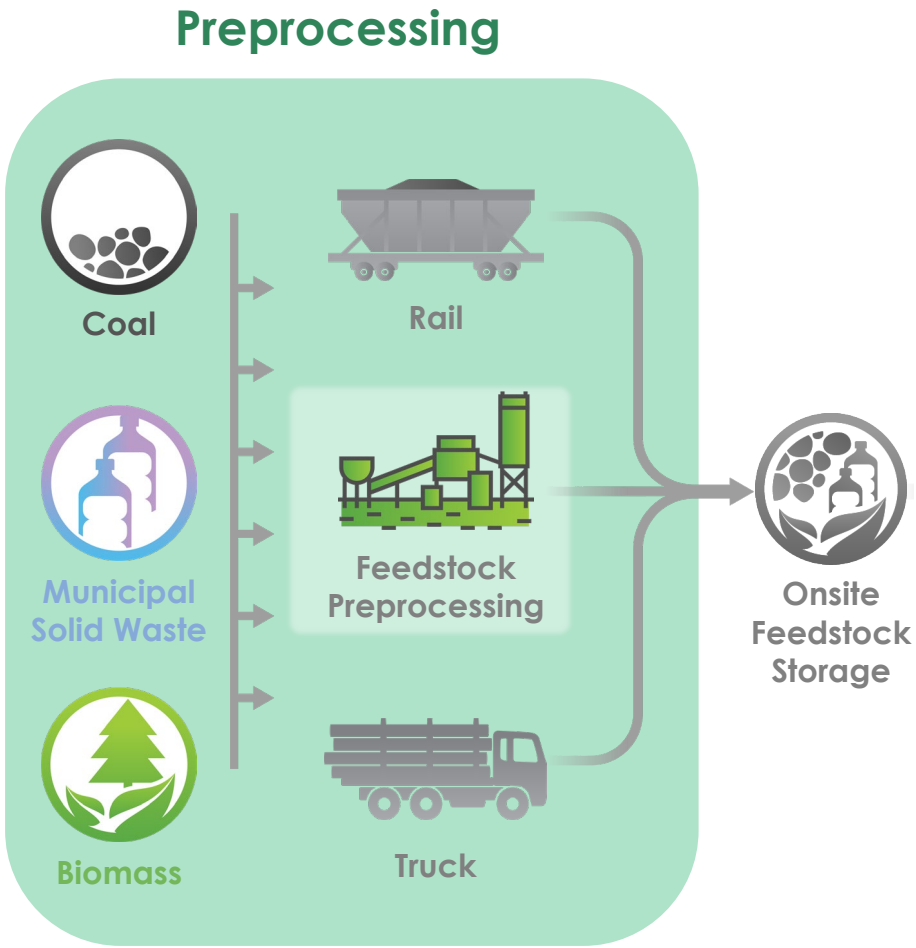
Activities Across the National Laboratories

- Collect and Characterize Feedstock
- Produce a Range of Feedstock Based on Resource Assessment for all NLGC Experiments
- Archive Metadata, Analysis, and Physical Samples
- Preprocessing, Separations, and Formatting
- Decontaminate Feedstock
- Relate Feedstock Quality and Conversion Performance
- Improve Preprocessing Diagnostics



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Upstream Feedstock Quality and Preprocessing

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Biomass Feedstock National User Facility (BFNUF)

A national asset to de-risk the scale up of the bioeconomy, transforming diverse biogenic carbon sources and wastes into feedstocks for specific conversion processes.

Goal	Understand the fundamentals of material preprocessing, which will ultimately mobilize feedstocks for clean fuels, chemicals and products

Only facility in the world with the wide range of mechanical preprocessing capabilities to manage the diversity of raw biomass and waste resources.

- Capabilities range from gram/kilogram per hour scale to the ton per hour scale
- Reconfigurable testbed for public and private sectors

Upstream Feedstock Quality and Preprocessing

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Representative Preprocessing Pathways

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Southern Yellow Pine, Coal, MSW

Initial Shredding

Coarse Shredding

Fine Shredding

Formulated Feedstock Blends

Initial Shredding

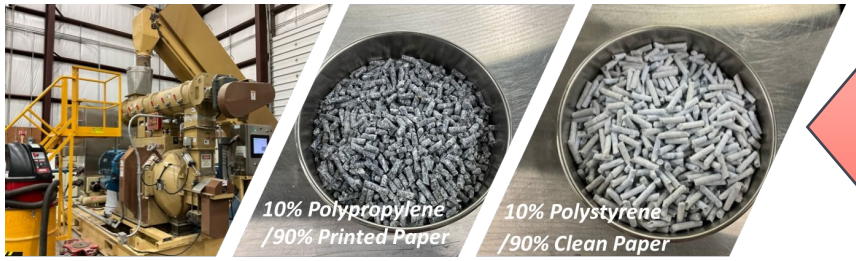
Sizing

Bulk Mixing

Single Pellet Mixing

Pellet Mill

Pellet Press



Mixture Components

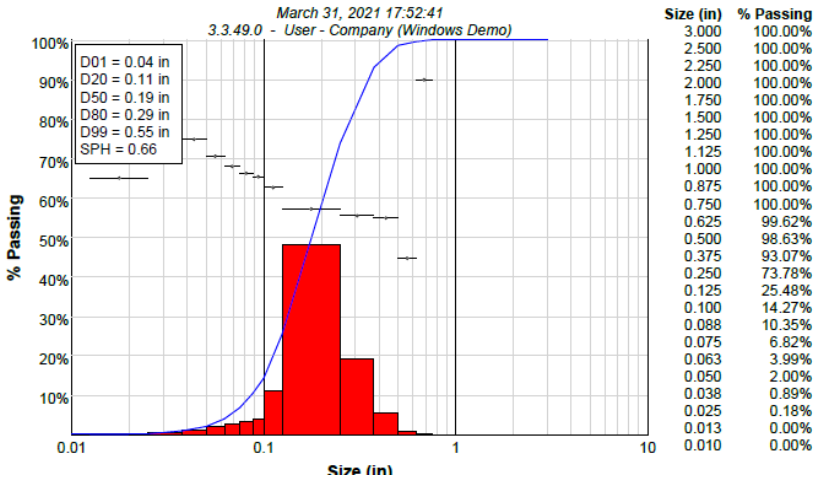
Classification

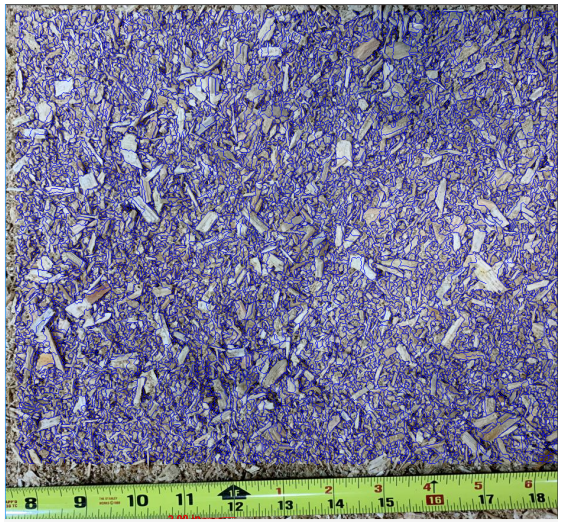
Coarse Shredding

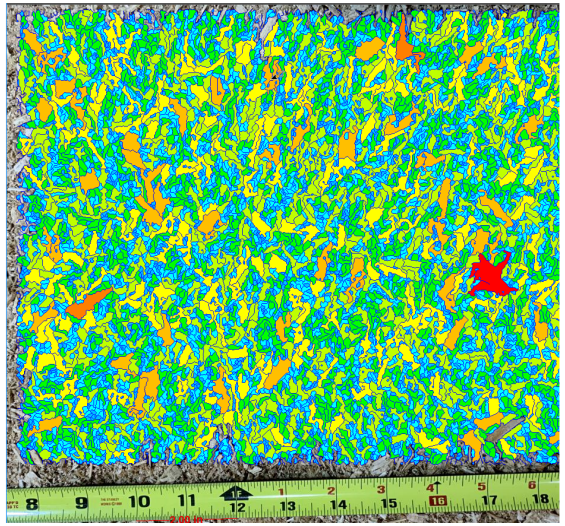
Fine Shredding

Processing Diagnostics

- Active measurement during processing
- Feedback characteristics to processing systems





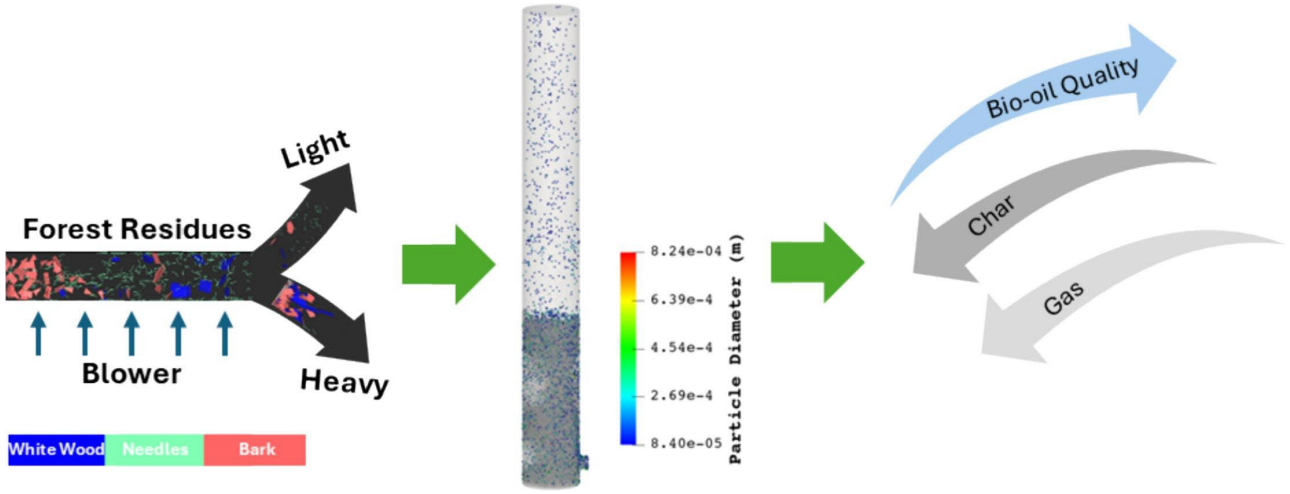


Integrated Preprocessing-Conversion Example

Coupled TEA with Preprocessing and Conversion Models

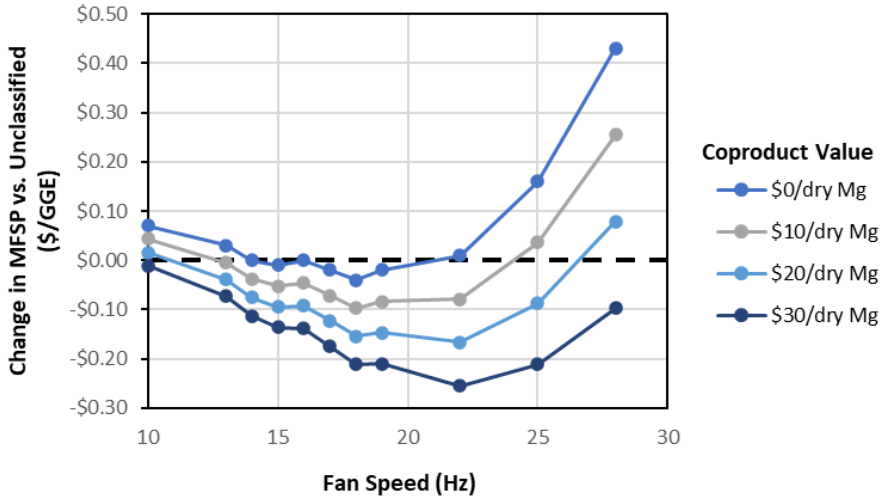
- **Establish relationships** between preprocessing intensity and feedstock quality
- Changing feedstock quality led to **variable conversion performance**, reflected through Techno-economic Assessment

Fractionation of low-performance and contaminant species improved product yields and quality



doi.org/10.1016/j.fuel.2024.132572

This led to improved performance and cost savings for CFP, especially where there was coproduct valuation

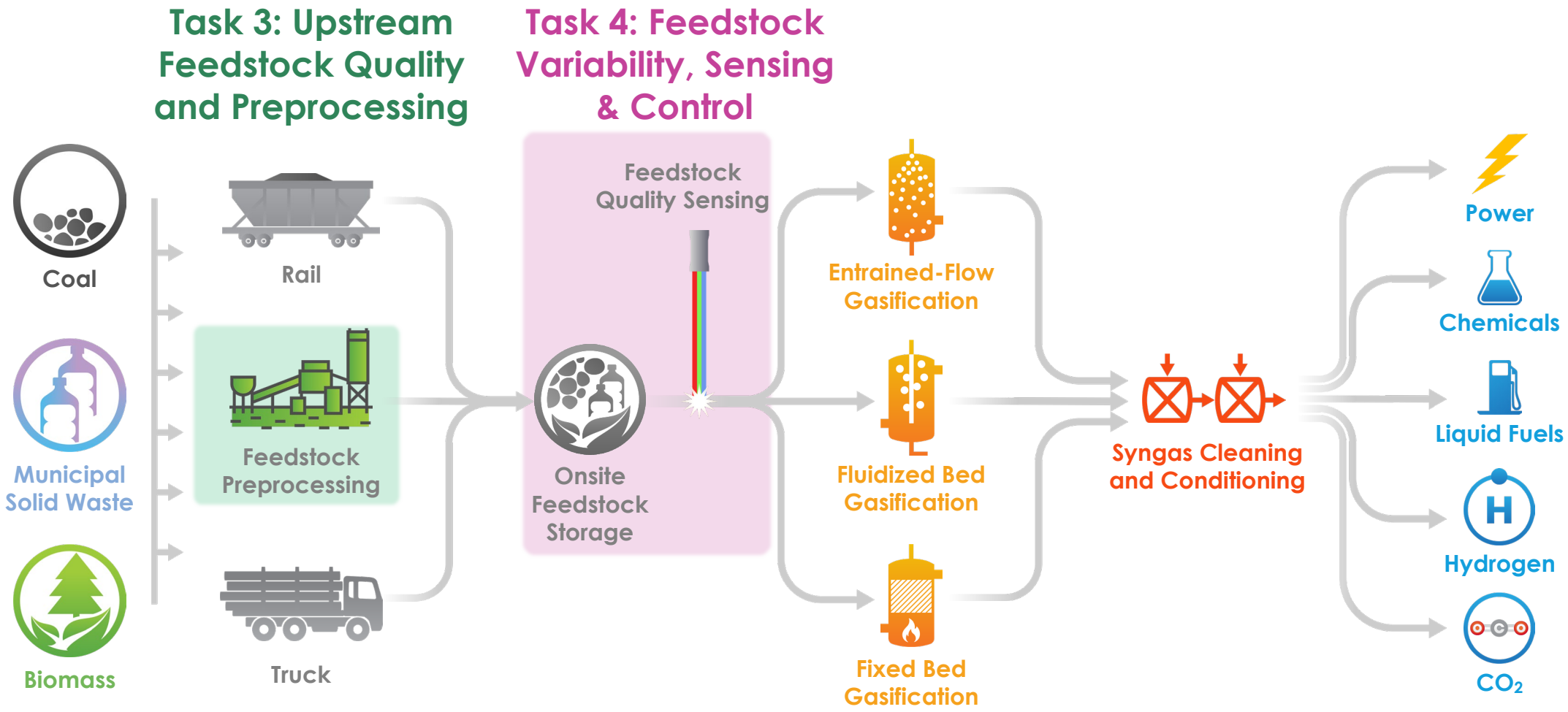


https://doi.org/10.1016/j.nxener.2024.100225

NLGC Overview

NLGC
National Laboratory
Gasification Consortium

Task Level Scope



Feedstock Variability, Sensing, & Control

NLGC
National Laboratory Gasification Consortium

Goal

- Implement a **cost-effective** combination of sensing technologies to provide detailed **characterization of feedstock** entering the gasifier

Objectives

- Leverage **existing knowledge** from **MSW sortation**
- **Engage reactor operators and control experts**; define feedstock material attributes and control approaches including potential benefits of **feedstock standards**
- Evaluate **existing and emerging sensing modalities** for inlet characterization
- **Publish open database and analysis methods**; access accuracy and robustness of methods
- Demonstrate real-time system at the **pilot scale**

Feedstock Variability, Sensing, & Control

NLGC National Laboratory Gasification Consortium

Team

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INL

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Ed Wolfrum
NREL

Zophia Tillman
NREL

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NETL

Dan Hartzler
NETL

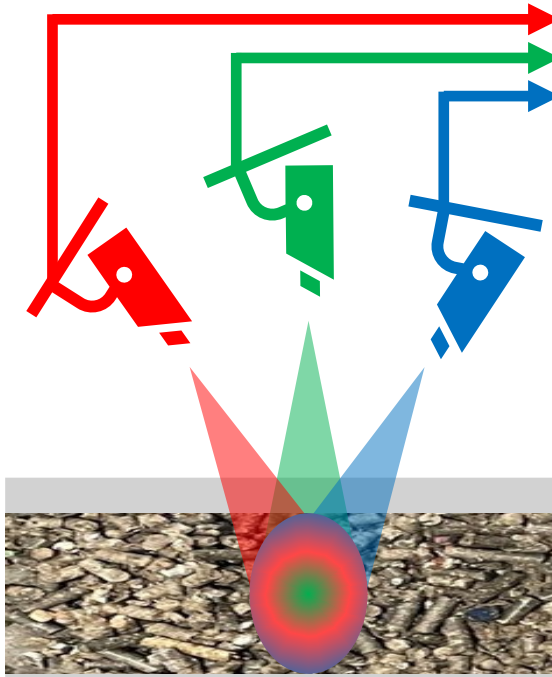
Bob Wallace
NETL

Feedstock Variability, Sensing, & Control

NLGC National Laboratory Gasification Consortium

Pre-Processing & Meta Data

Multiple Sensors
- **NIR/MIR**
- **LIB/XRF**
- **Imaging**



Data Analysis & Correlation

Feed-Forward Information for Gasifier Control
- Classification of Blends
- Moisture Content
- Chemical Composition
- Ash Content & Chemistry
- Mass & Energy Density
- Particle & Pore Size & Shape

Pre-Processed Feedstock

To Gasifier

Cross-Cutting Activities

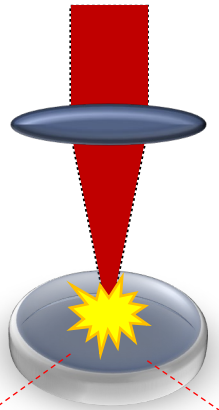
- Industry Discussions
- Database Curation
- Control Strategy Integration
- Pilot-Scale Demonstration

Building on NL Capabilities & Experience

NLGC National Laboratory Gasification Consortium

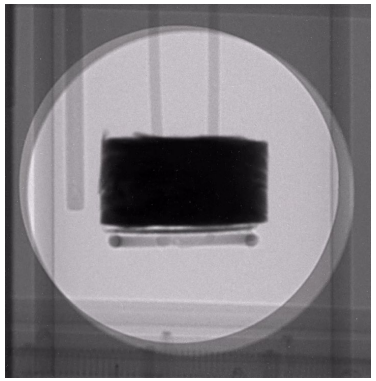
Experience base includes previous Fossil Energy projects

NATIONAL ENERGY TECHNOLOGY LABORATORY | NREL NATIONAL RENEWABLE ENERGY LABORATORY | OAK RIDGE National Laboratory | INL Idaho National Laboratory

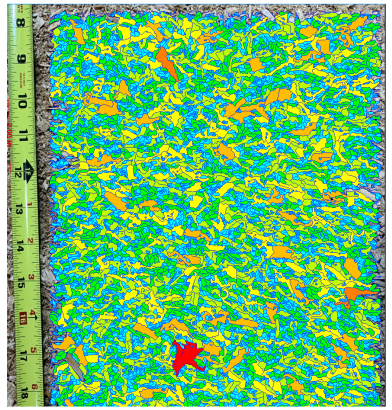


Laser Induced Breakdown Spectroscopy

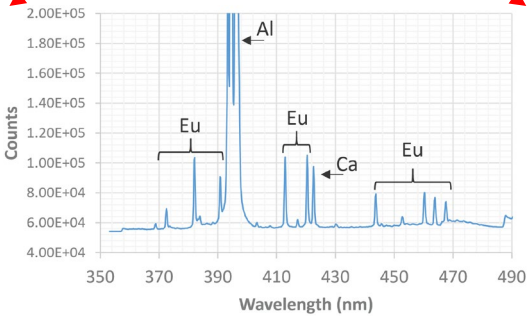
Near Infrared Spectroscopy



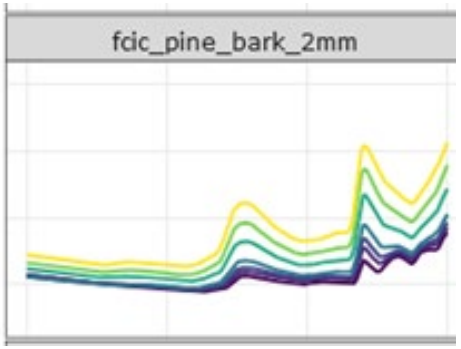
Neutron Imaging



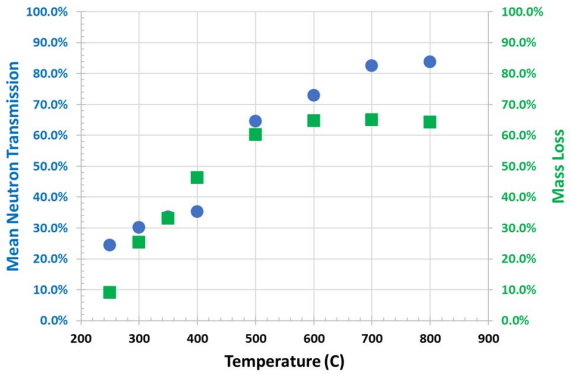
On-Line Particle Imaging



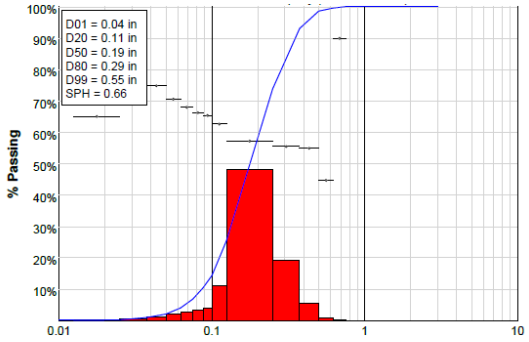
Elemental Composition



Chemical Composition



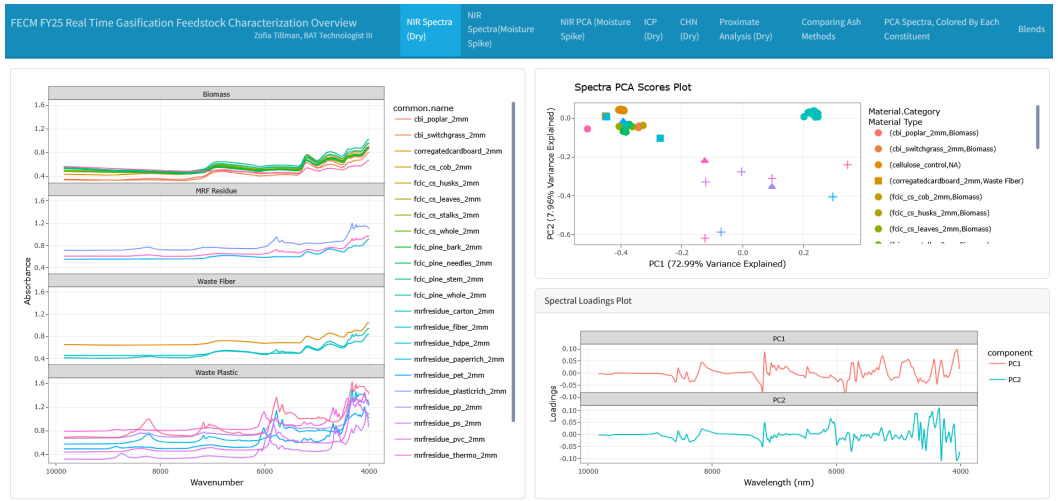
Mass and Heat Transfer

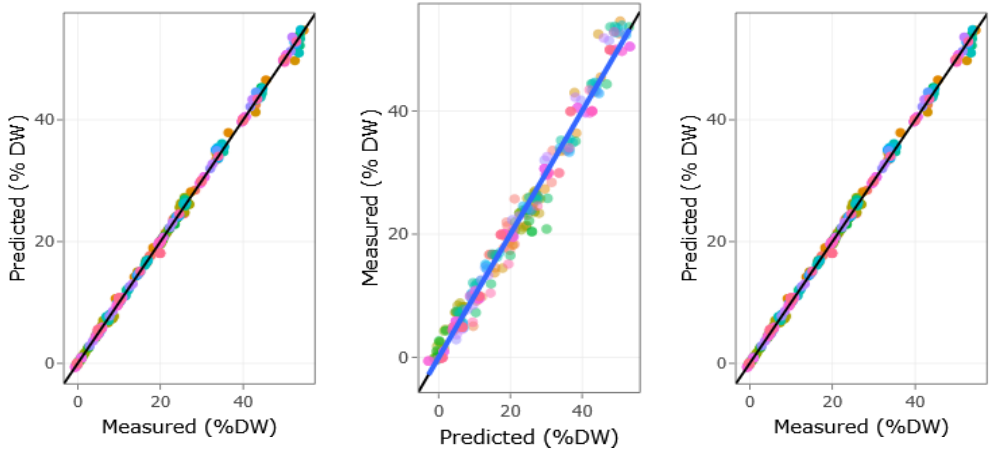


Particle Size Distribution

Non-Imaging Near-Infrared (NIR) Spectroscopy

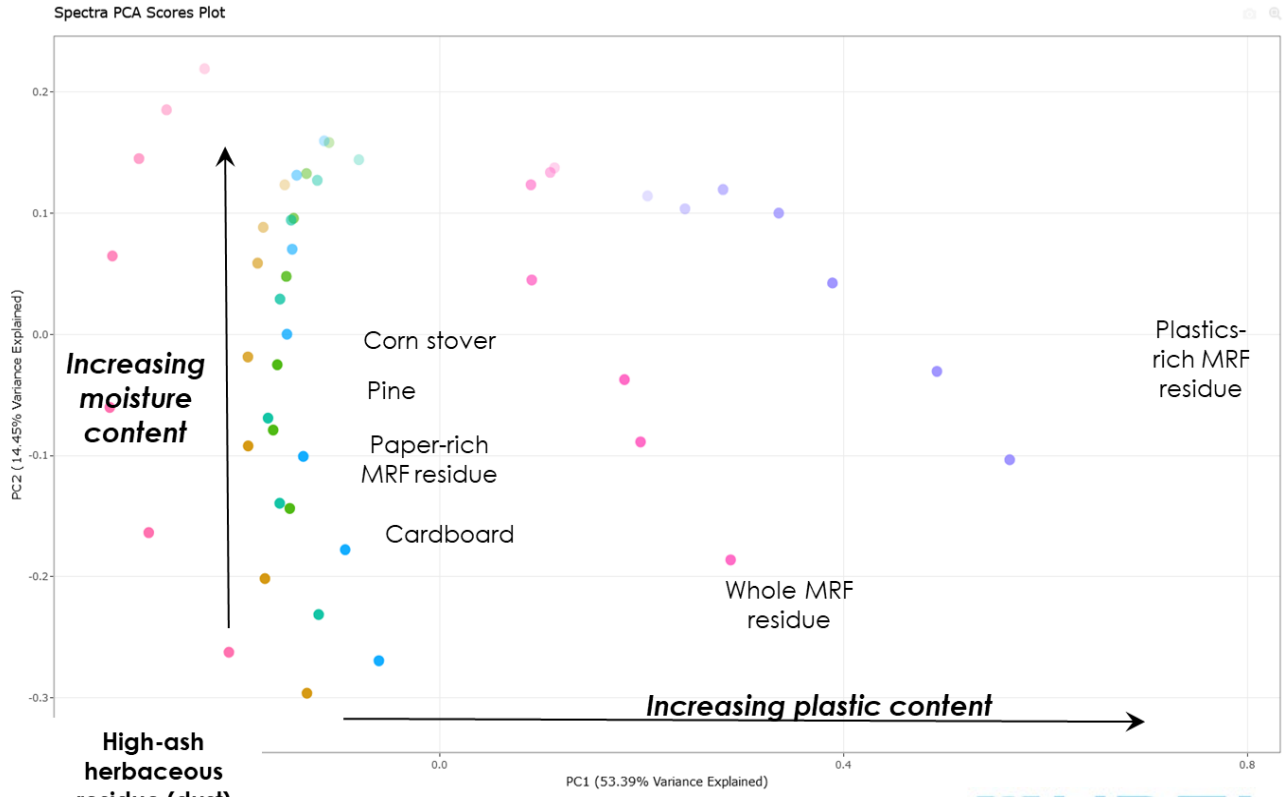
Open-Source Workflows Ensure Reproducible Research





Multiple modeling approaches provide acceptable bulk moisture predictions

Multivariate analysis of NIR data can be used to distinguish different feedstock types (plastic waste, paper waste, biomass) and can quantify bulk moisture content

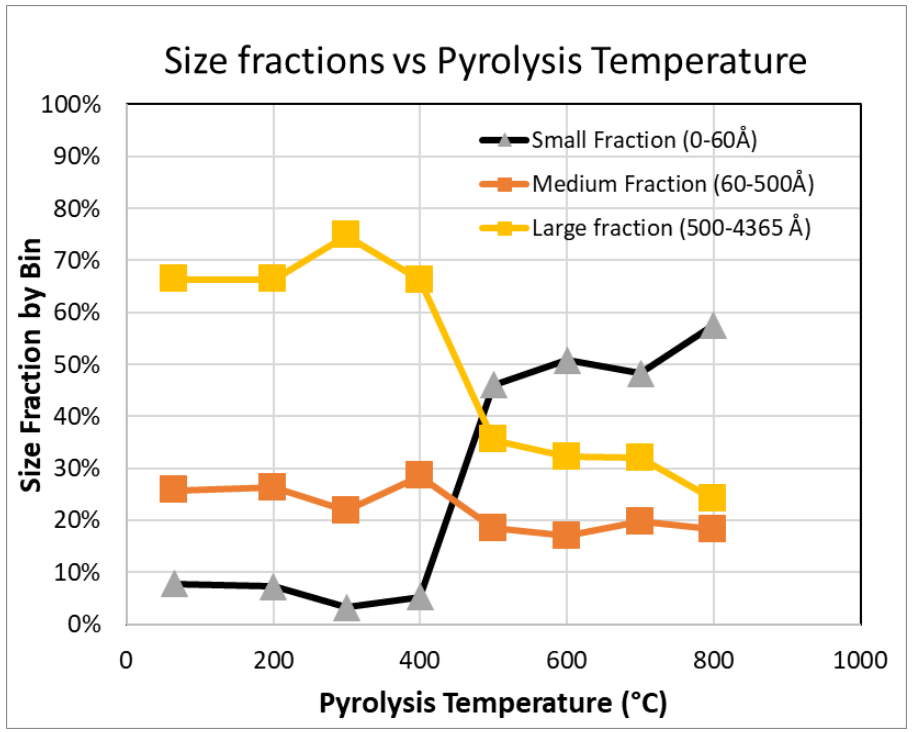


Neutron Techniques Provide Detailed Characterization

NLGC National Laboratory Gasification Consortium

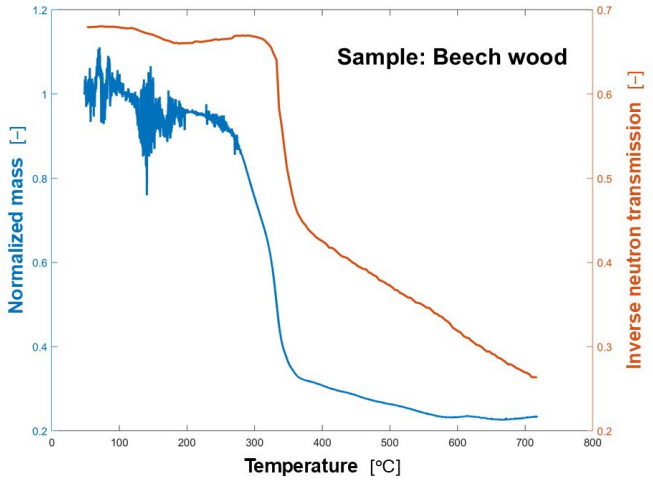
Small Angle Neutron Scattering (SANS)

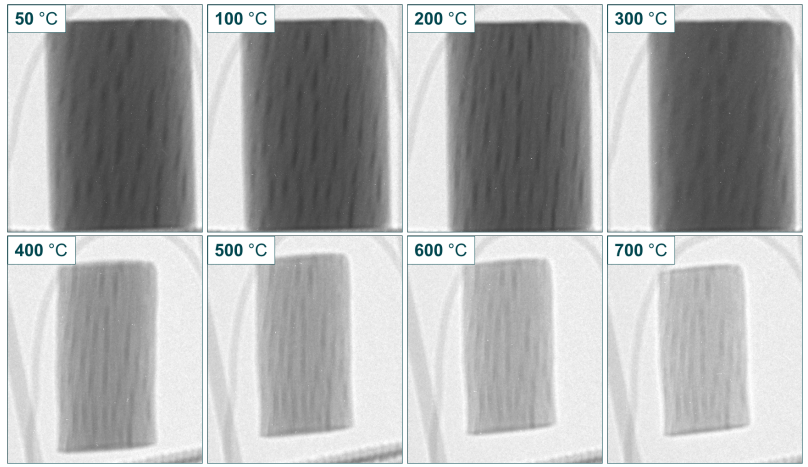
- SANS porosity measurements during pyrolysis show a substantial increase in small pores above 500°C



In-Situ Neutron Imaging with Thermogravimetric Analyzer (TGA)

- *In-situ* imaging show substantial carbon loss during TGA analysis; good correlation with conventional mass loss data





Darker images are samples with higher Hydrogen content

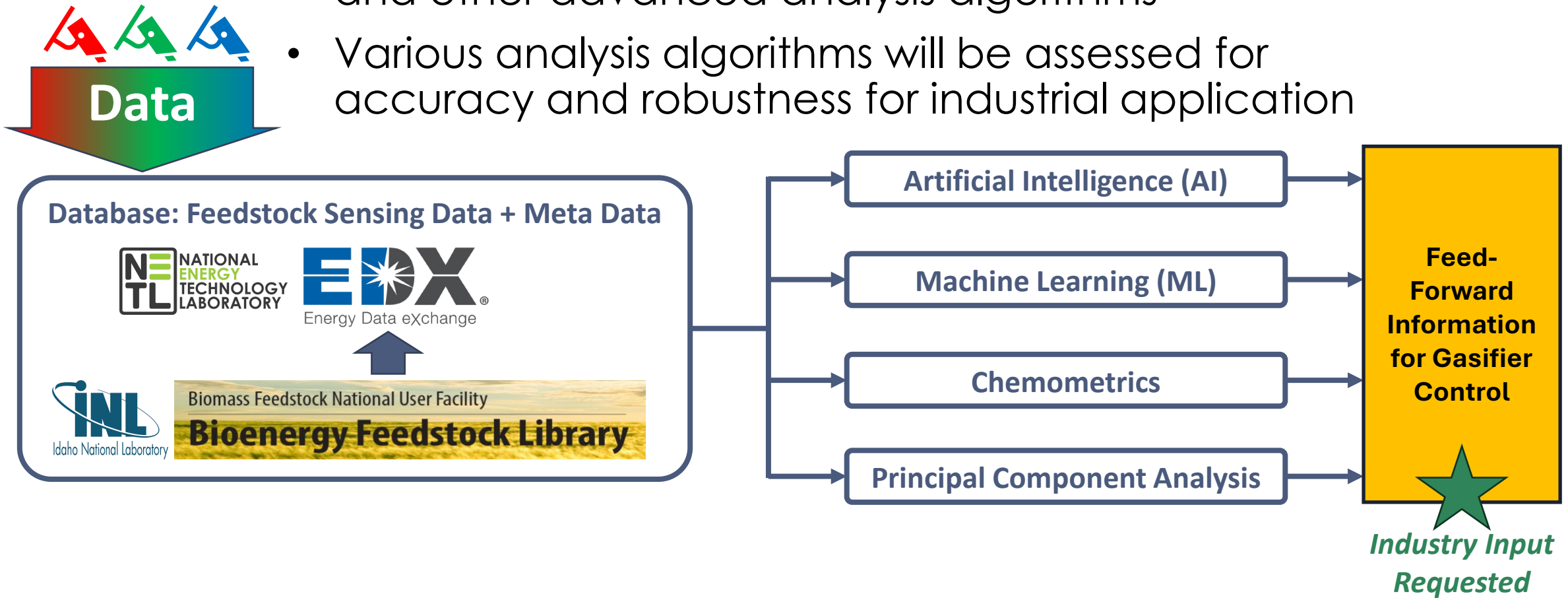
OAK RIDGE National Laboratory

Creating Open-Source AI-Ready Database

NLGC National Laboratory Gasification Consortium

Public sharing of database & analysis algorithms for feed forward information

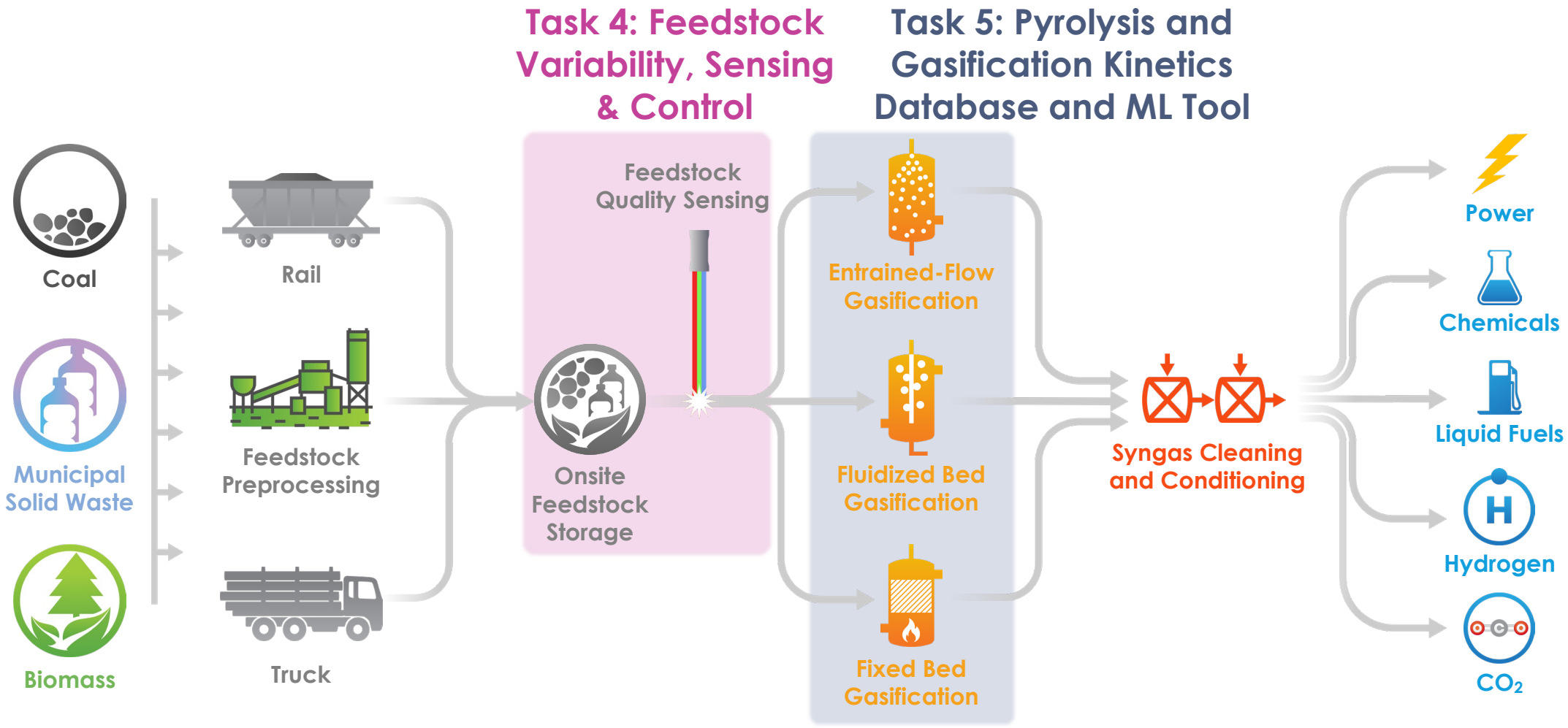
- An extensive database will be curated to enable AI and other advanced analysis algorithms
- Various analysis algorithms will be assessed for accuracy and robustness for industrial application



NLGC Overview

NLGC
National Laboratory
Gasification Consortium

Task Level Scope



Kinetics Database and Machine Learning Tool

NLGC National Laboratory Gasification Consortium

Goal

- To develop a repository of validated reaction kinetics and product distributions for diverse feedstocks undergoing pyrolysis and gasification. The repository will include the capability to generate kinetics and product distributions for cases where experimental data is currently unavailable.

Objectives

- To develop KinetiXHub, an interactive platform featuring a data repository and machine learning-based tools for validated kinetic models. This platform will provide reaction rates and product distributions for mixed feedstocks, including biomass, waste plastics, and coal.

Kinetics Database and Machine Learning Tool

NLGC National Laboratory Gasification Consortium

Activities Across the National Laboratories

NATIONAL ENERGY TECHNOLOGY LABORATORY

- Literature Survey
- Intrinsic Reaction Kinetics & Product Distribution of Pure and Blended Feedstock
- Apparent Reaction Kinetics & Product Distribution Model Development
- Kinetic Model Validation in CFD
- Kinetic Database Development

OAK RIDGE National Laboratory

- Evolution of Particle Morphological and Textural Properties

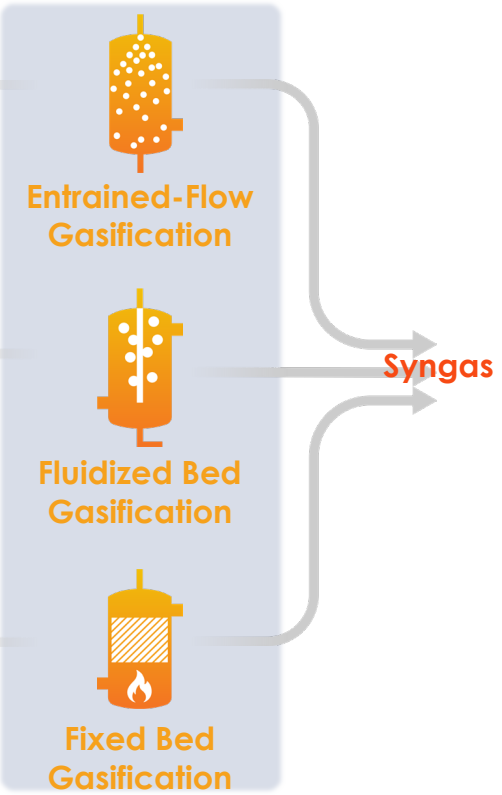
NREL NATIONAL RENEWABLE ENERGY LABORATORY

- Particle-Scale Model to Account for Heat & Mass Transfer Effects
- Single Particle Reactor and NREL Research Gasifier Validation Experiments

INL Idaho National Laboratory

- Feedstock acquisition (BFNUF)

Co-gasification modeling



Kinetics Database and Machine Learning Tool (NETL)

NLGC National Laboratory Gasification Consortium

Develop and validate kinetic models and product distribution for blended feedstock of coal, biomass and waste plastic

Project Team


Mehrdad Shahnam


Ping Wang


Wei Shi

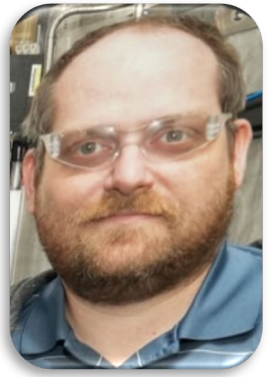

Jarrett Riley


Ross Houston


Aytekin Gel


Aamir Bashir


Jennifer Weidman


Michael Bobek


Chris Atalla

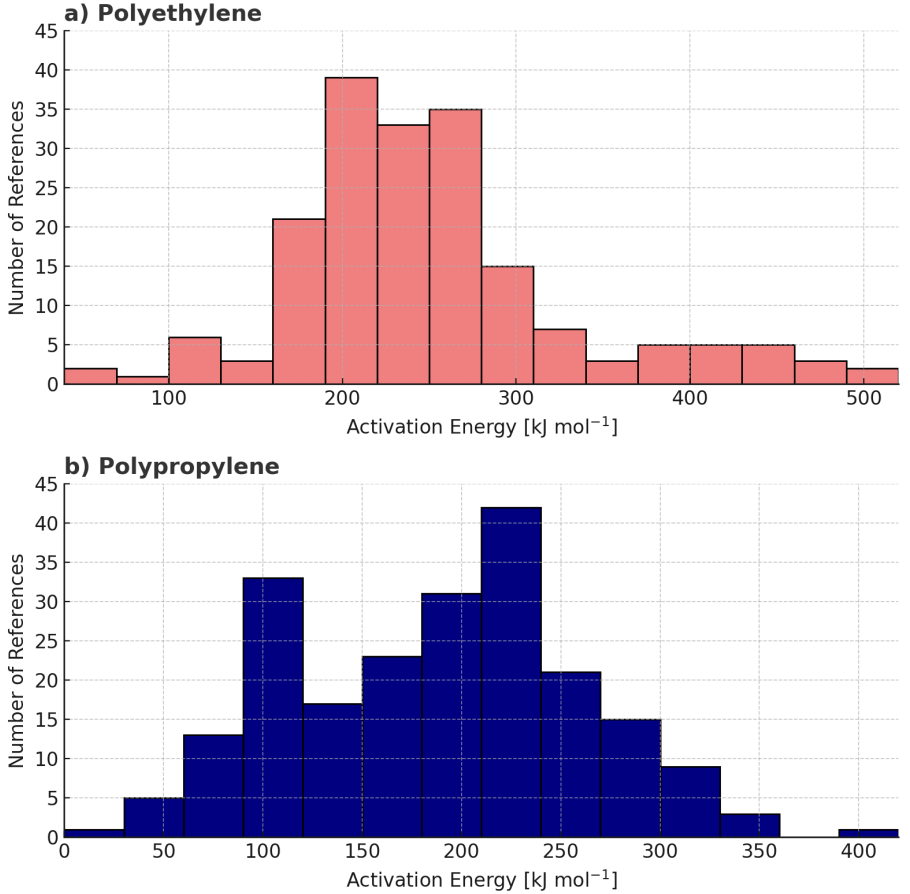
Kinetics Database and Machine Learning Tool (NETL)

NLGC National Laboratory Gasification Consortium

Literature Survey

- Initial literature review focuses on plastic pyrolysis kinetics, for polyethylene (PE) and polypropylene (PP)

- Variations in reported kinetics data arise from differences in feedstock property (proximate and ultimate analysis), chemical compositions, particle size, experimental setup, test procedure (sample mass, heating rate), and modeling approach



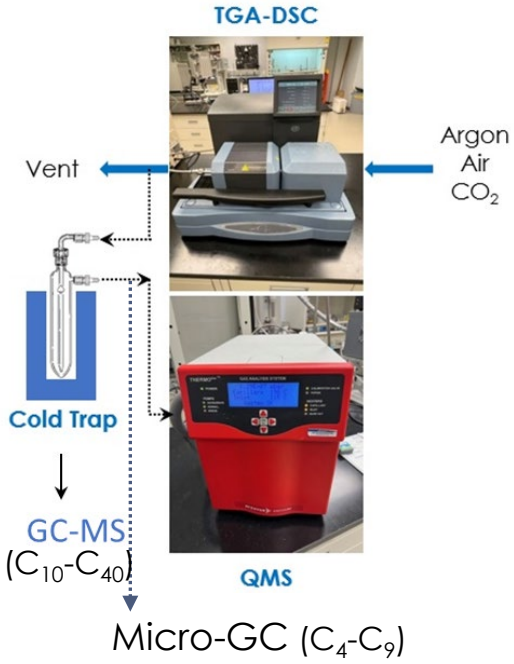
Literature-reported activation energy variation of polyethylene and polypropylene pyrolysis.
Mastalski et al. (2023).

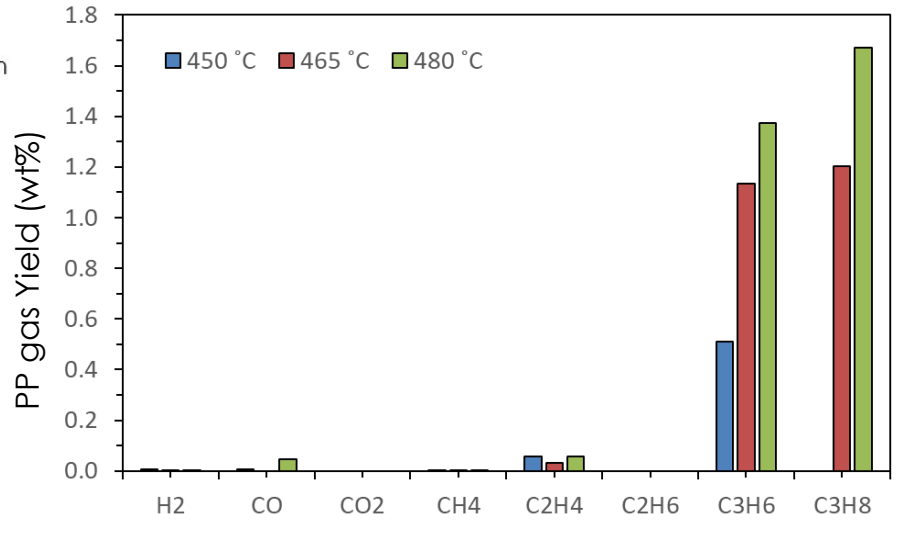
Kinetics Database and Machine Learning Tool (NETL)

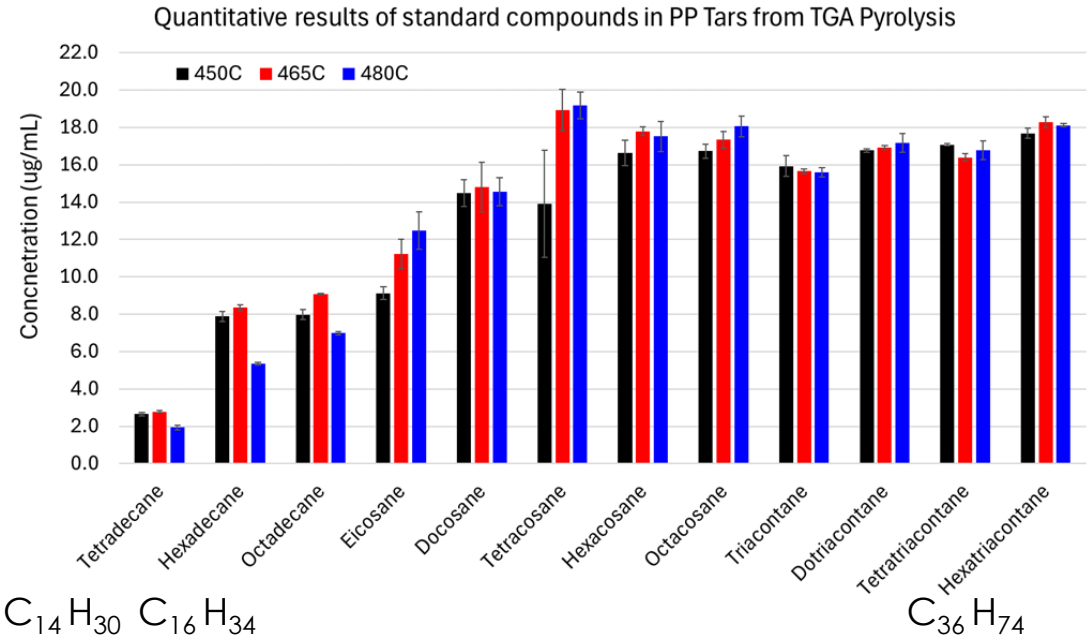
NLGC National Laboratory Gasification Consortium

Develop and validate kinetic models and product distribution for blended feedstock of coal, biomass and waste plastic

- Develop intrinsic reaction kinetics and product distribution for pyrolysis & gasification of plastic (PE, PP, PS, PET), biomass, and coal at multiple heating rates, up to 20 bars
  - ➢ TGA experiments have been conducted for PP with tar composition determined by grouping hydrocarbons (alkane with C_{14} to C_{36})



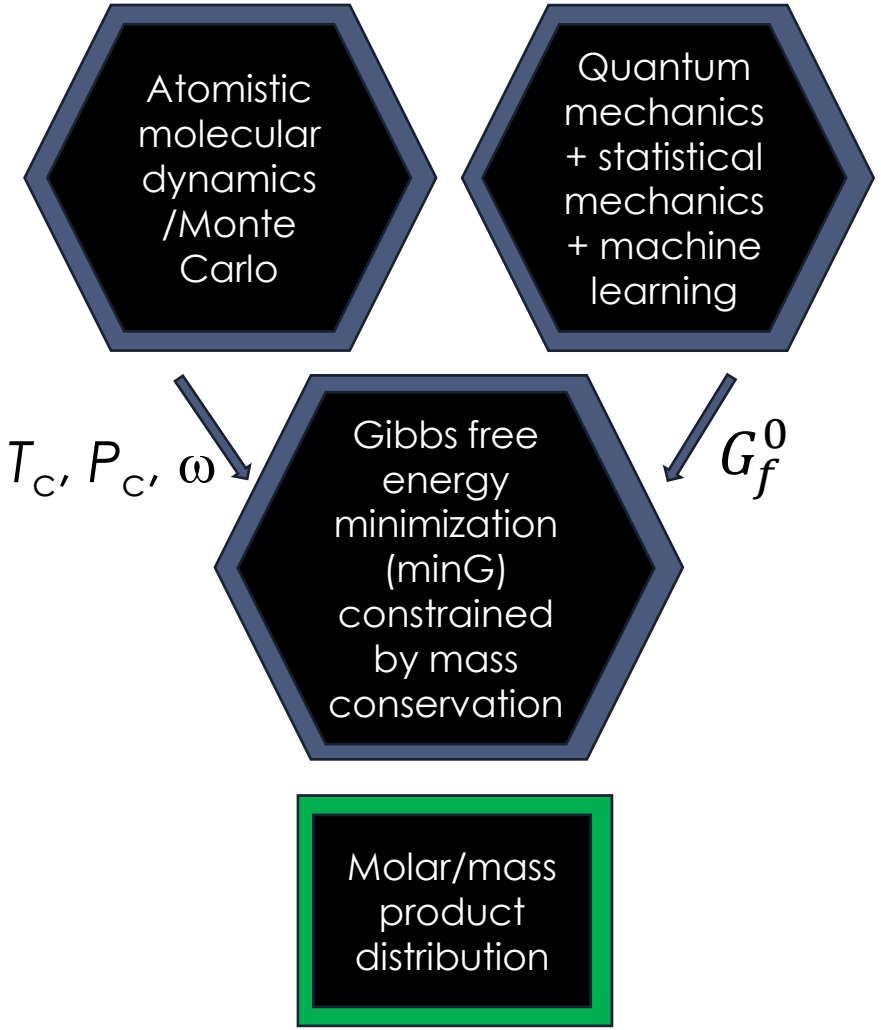


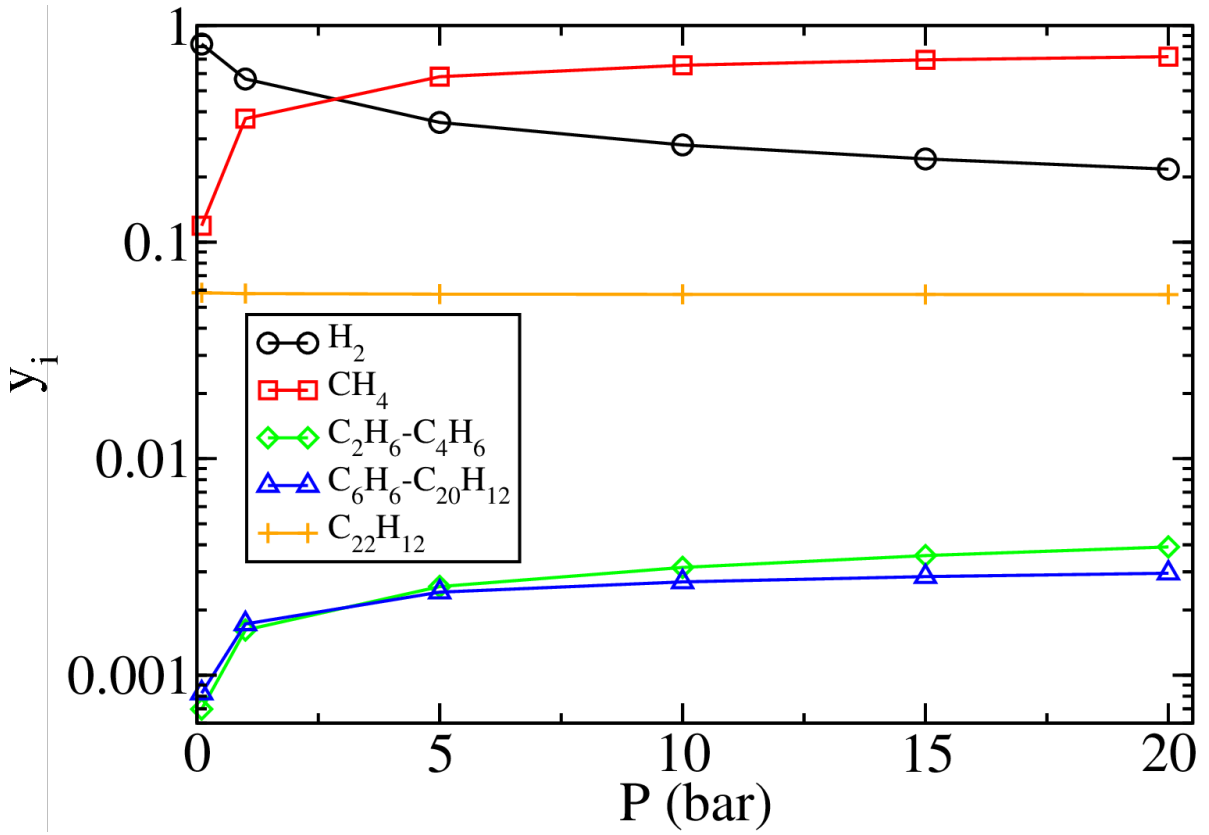


Kinetics Database and Machine Learning Tool (NETL)

NLGC National Laboratory Gasification Consortium

Computational Method to Predict Equilibrium Secondary Tar Cracking Product Distribution

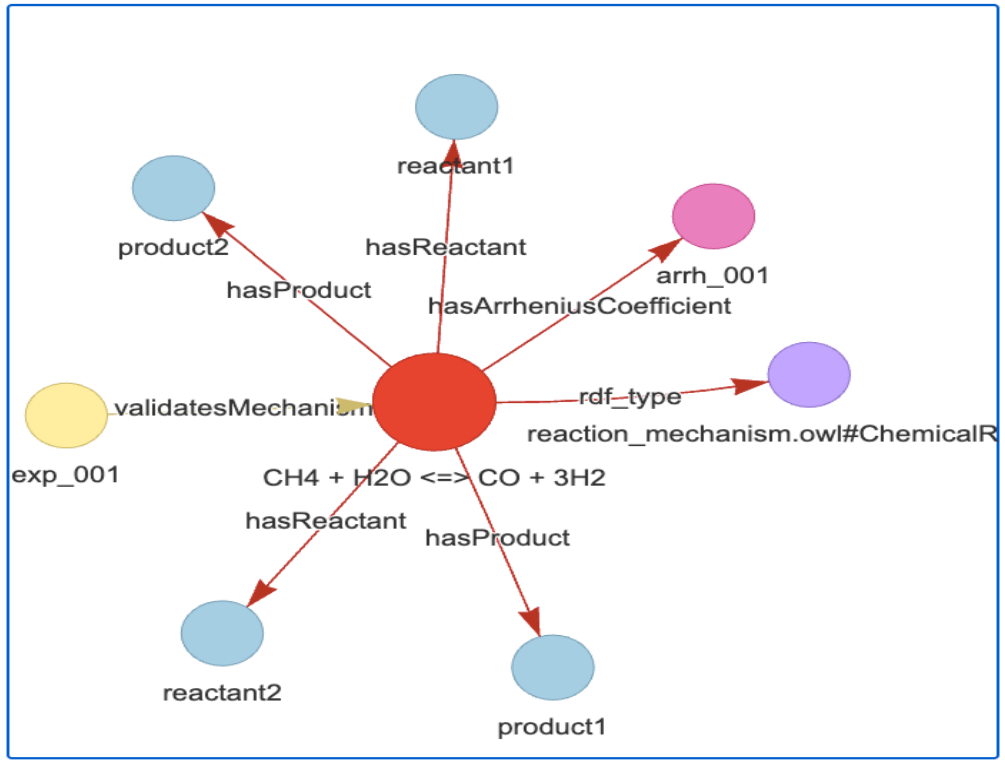


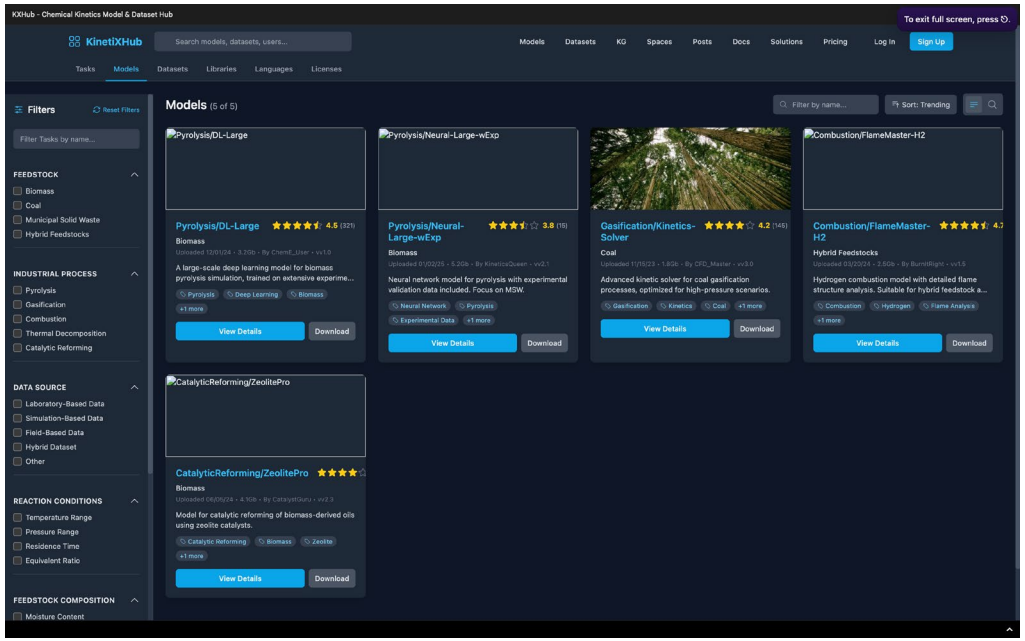


Kinetics Database and Machine Learning Tool (NETL)

Kinetic Database Development

- Develop a searchable web portal kinetic repository (KinetiXHub), where kinetic data can be browsed, and downloaded





➢A simplified knowledge graph for a simple reaction were constructed for proof-of-concept demonstration

Methane Steam Reforming reaction

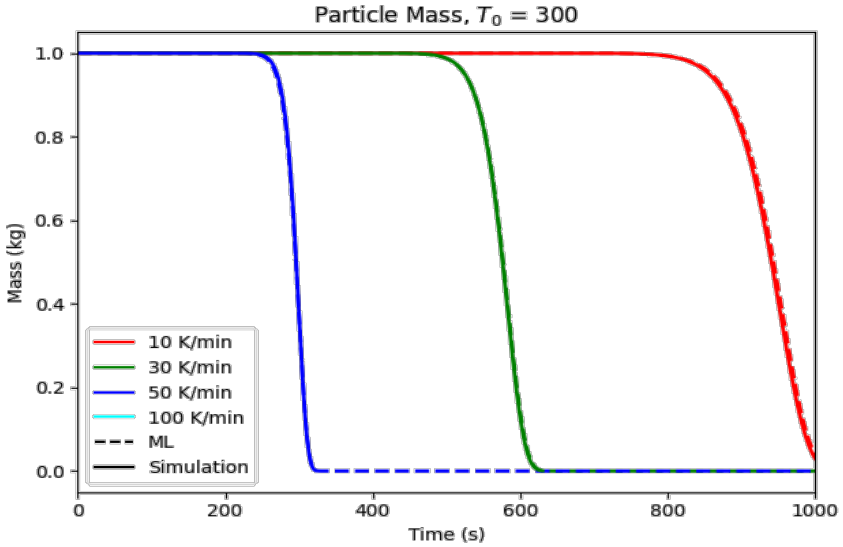
- ❖$CH_4 + H_2O \Leftrightarrow CO + 3H_2$
- ❖A mock TGA data (exp_001)
- ❖A mock Arrhenius rate constant (arrh_001)

Kinetics Database and Machine Learning Tool (NETL)

NLGC National Laboratory Gasification Consortium

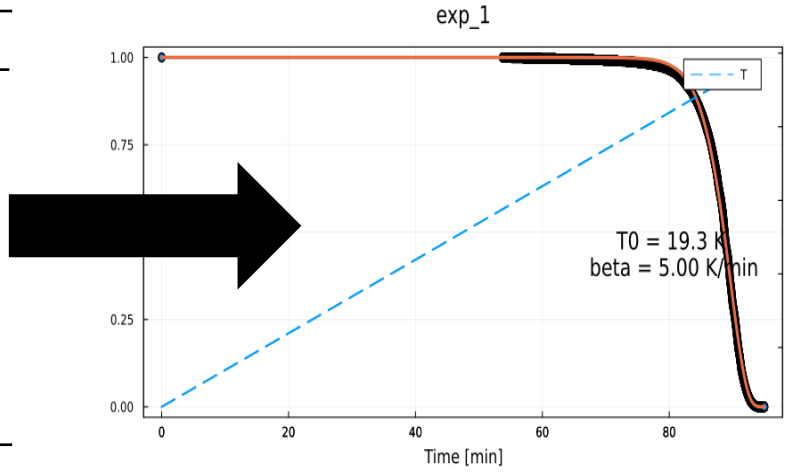
Kinetic Database Development

- Develop a ML framework for estimating the reaction rate and product distribution of a feedstock not available in the repository
- Develop an ML surrogate model for detailed reaction schemes with many tens of reactions and species
- Develop an ML methodology to provide apparent kinetic rate and product distribution for feedstock, based on TGA data



Particle Mass Loss Curves – ML vs Kinetic Scheme

Reaction	Reaction Rate
0.35LDPE + 0.16S1 → 0.46S2 + 0.05Volatiles	$4.85e4 * T^{0.07} e^{\frac{-106.74}{RT}}$
0.81S2 → 0.27S1 + 0.55 Volatiles	$1.43e6 * T^{0.21} e^{\frac{-76.89}{RT}}$
0.72LDPE + 0.02S1 → 0.63S2 + 0.11Volatiles	$5.84e6 * T^{0.19} e^{\frac{-83.09}{RT}}$
0.32S2 → 0.1S1 + 0.22Volatiles	$1.28e4 * e^{\frac{-117.31}{RT}}$
0.23S2 → 0.23S1	$3.06e5 * T^{0.04} e^{\frac{-100.49}{RT}}$
0.69S1 → 0.6S2 + 0.09Volatiles	$5.80e5 * T^{0.18} e^{\frac{-68.96}{RT}}$



Prediction of Kinetic Parameters to Create Reaction Schemes

Kinetics Database and Machine Learning Tool (INL)

NLGC National Laboratory Gasification Consortium

Feedstock Acquisition

- Interfacing with Upstream Feedstock Quality and Preprocessing
  - Critical feedstock attributes are tracked across preprocessing steps, analyzed, and archived
  - Critical feedstock attributes likely impact reaction kinetic and conversion pathway for a feedstock
    - Size distribution
    - Density (skeletal and envelope)
    - Effective porosity, sphericity and shape factor
    - Proximate and ultimate analysis
    - Chemical composition (cellulose, hemicellulose, lignin, tannin, extractives, ash, moisture content, heteroatom)
    - Ash speciation
    - Thermal conductivity, heat capacity, mechanical properties
    - Energy content

Project Team

Jordan Klinger

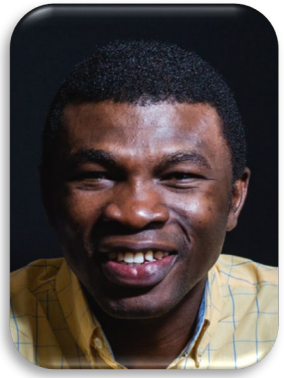
Saha Nepu

Kinetics Database and Machine Learning Tool (ORNL)

NLGC National Laboratory Gasification Consortium

Evolution of Particle Morphological and Textural Properties

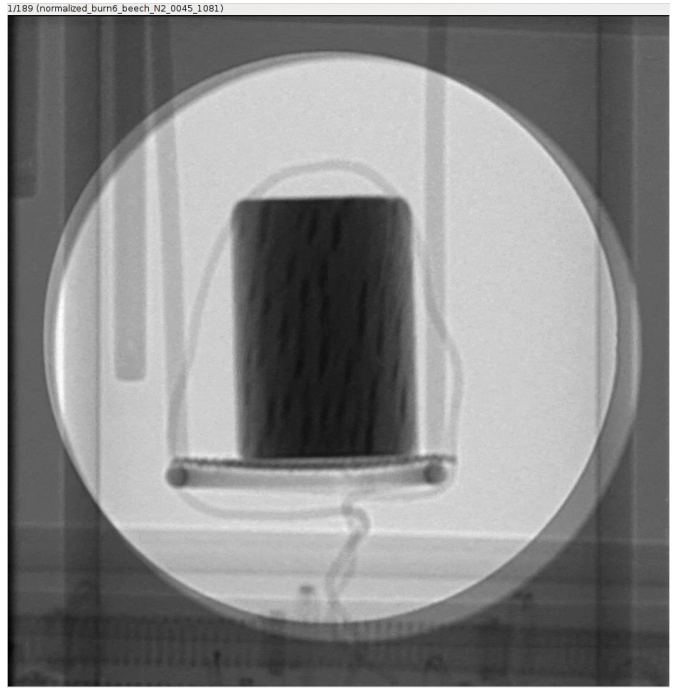
Project Team



Femi Oyedeji

Stephen Purdy

- Develop models to quantitatively describe how the pelletized feedstocks undergo physical and structural changes during pyrolysis and gasification processes
  - Leveraging advanced micro-TGA analysis
  - Characterizing solid residue and product distribution
  - Tracking changes in size, density, and porosity



Simultaneous Neutron radiography/TGA of beech wood pyrolysis

Kinetics Database and Machine Learning Tool (NREL)

NLGC National Laboratory Gasification Consortium

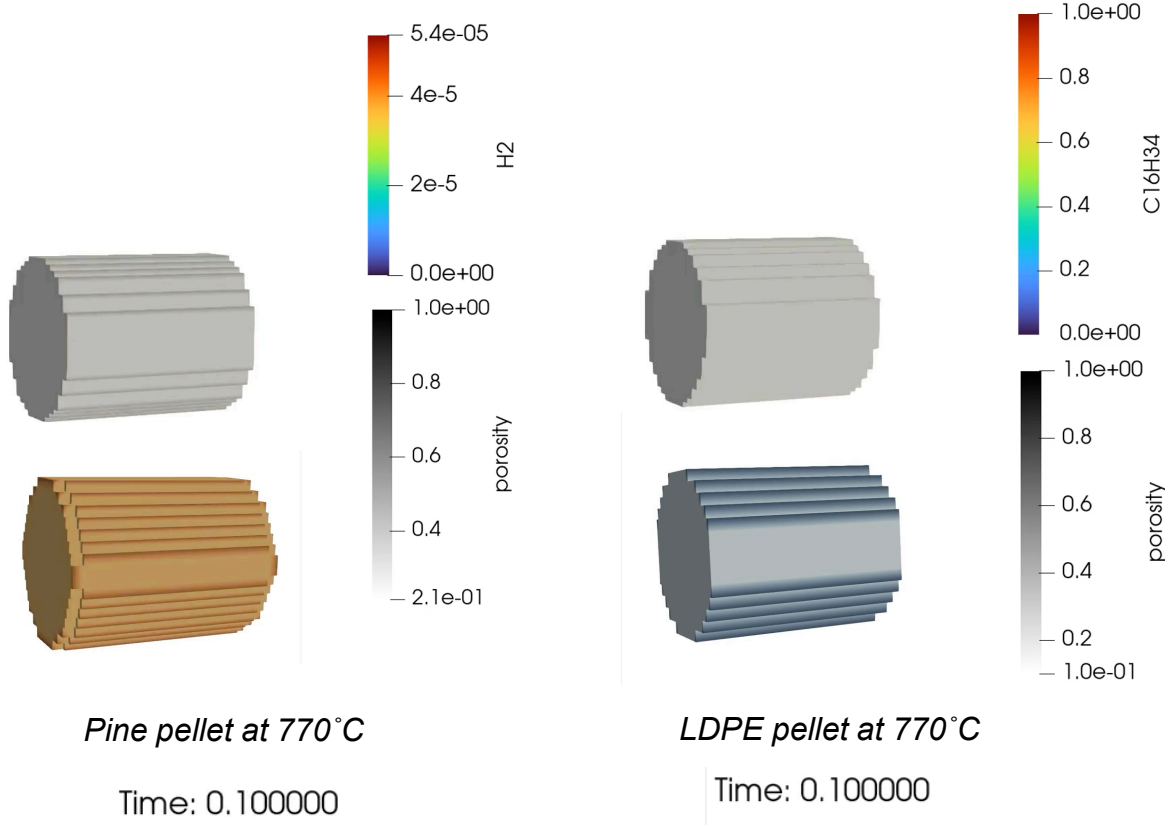
Develop a Particle Scale Model to Account for Heat & Mass Transfer Effects

Project Team

Peter Ciesielski

Meagan Crowley

- Particle scale simulations of pine and LDPE pellets at 770˚C, accounting for pellet shrinkage and matching experimental conditions of from the Single Particle Pyrolizer (SPR)



Kinetics Database and Machine Learning Tool (NREL)

Single Particle Reactor (SPR) and NREL Research Gasifier (NRG) Validation

Project Team


Anne Starace


Reinhard Seiser


Dan Dupuis


Ryan Ness


Clark Yarbrough


Kellene Orton


Cheyenne Paeper


Ella Slagel

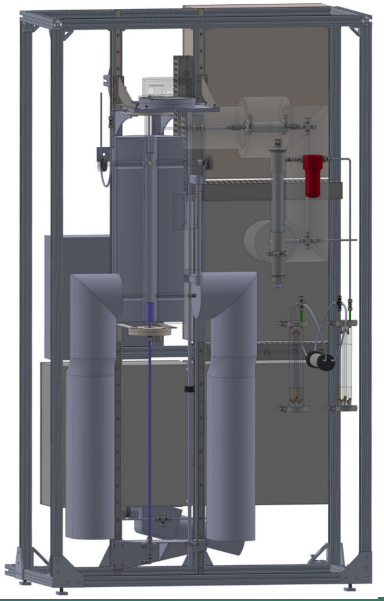
Kinetics Database and Machine Learning Tool (NREL)

NLGC National Laboratory Gasification Consortium

Single Particle Reactor (SPR) and NREL Research Gasifier (NRG) Validation

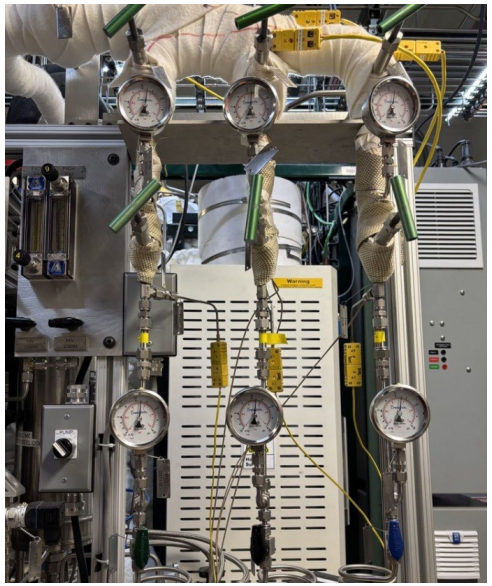
Single Particle Reactor

- Records Mass loss and temperature (free stream and internal particle)
- Optical Observation
- Gas bags for GC analysis
- Samples: single particles up to ¾" and 2 grams
- Rapid heating
- Process gases: nitrogen, steam, oxygen



NREL Research Gasifier

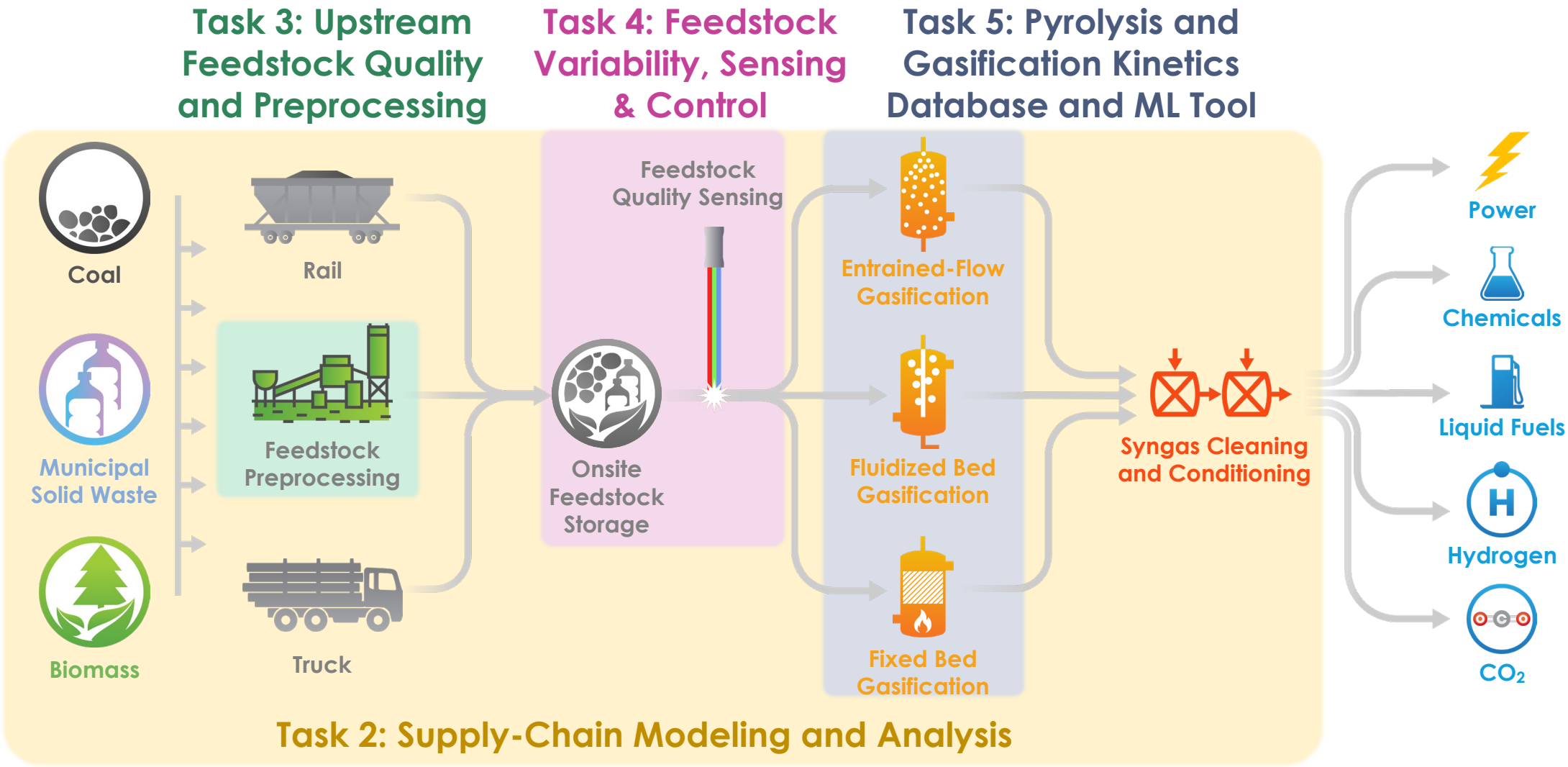
- Externally heated fluidized bed gasifier
- Continuous feeding with mass balances (typical 600 g/hr)
- Ex-situ catalytic reformer
- Amine scrubber
- Solid Phase Absorption for detailed tar characterization
- Online NDIR, TCD, and GC
- Process gases: nitrogen, steam, air



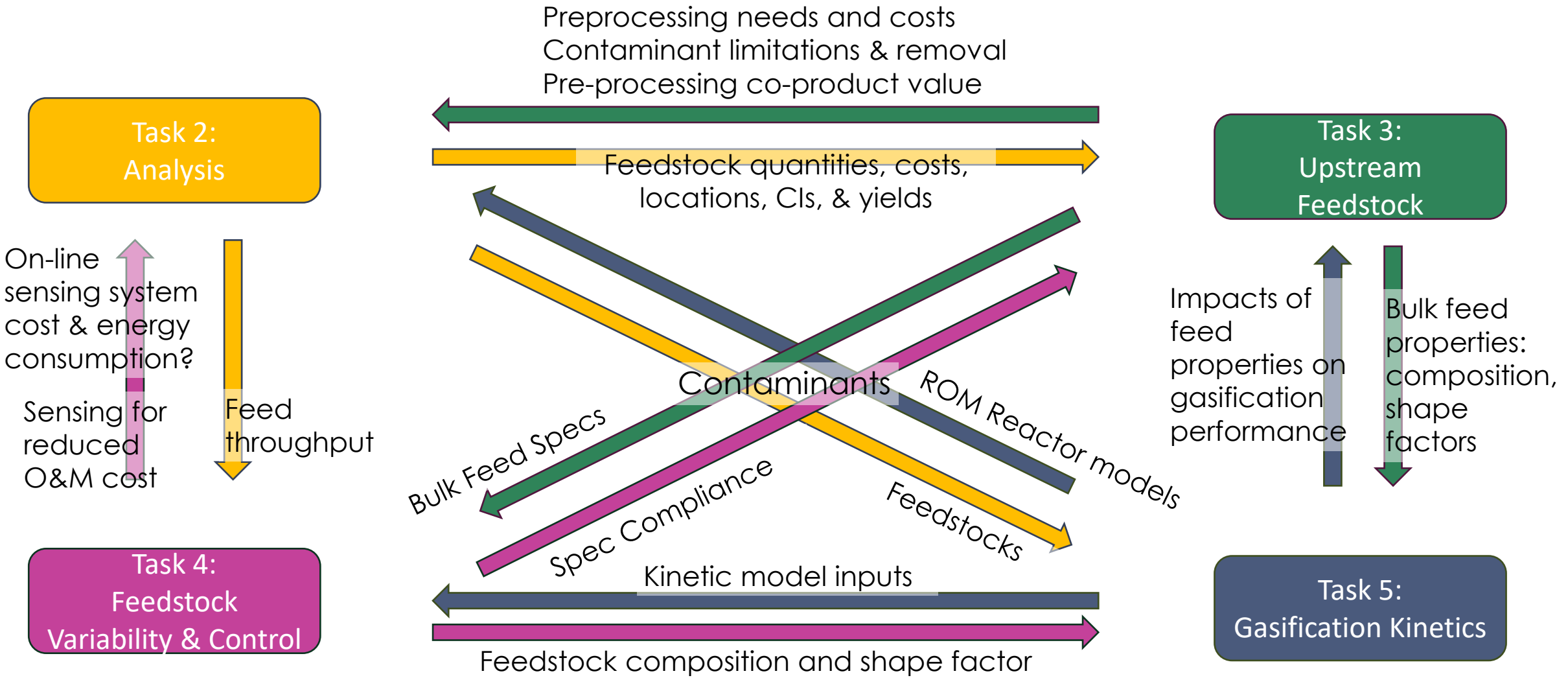
NLGC Overview

NLGC National Laboratory Gasification Consortium

Task Level Scope



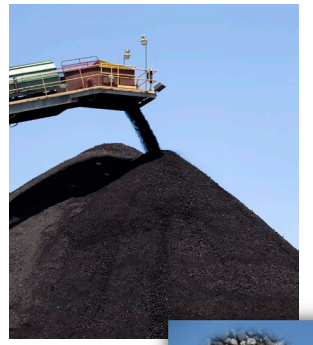
Technical Task Interactions

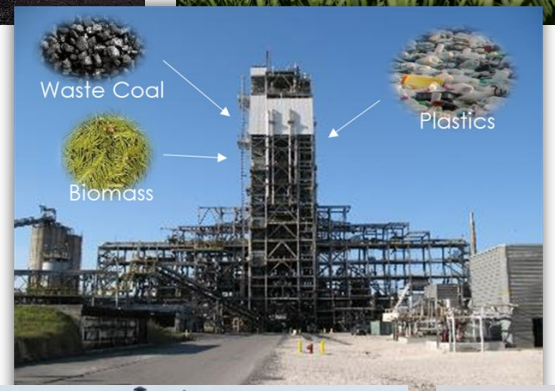


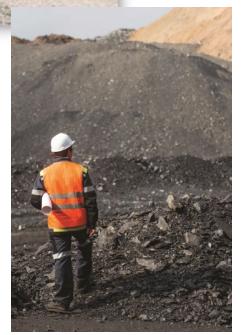
Summary

NLGC
National Laboratory Gasification Consortium

- **Goal:** To enable economic utilization of a broader spectrum of alternative and blended feedstocks to ensure fuel resiliency in gasification systems
- The NLGC will provide industry with information and tools to:
  - Assess economic gasifier siting as a function of feedstock availability, hydrogen markets, and waste stream disposition
  - Assess technical and economic tradeoffs in feedstock preprocessing, gasifier selection, and syngas cleanup needs
  - Deploy cost effective real-time sensing of feedstock variability for gasifier control
  - Estimate reaction kinetics and product distributions for most feedstocks and gasification conditions to enable accurate gasifier design and operability assessment
- Industry stakeholder involvement will ensure relevant and impactful R&D





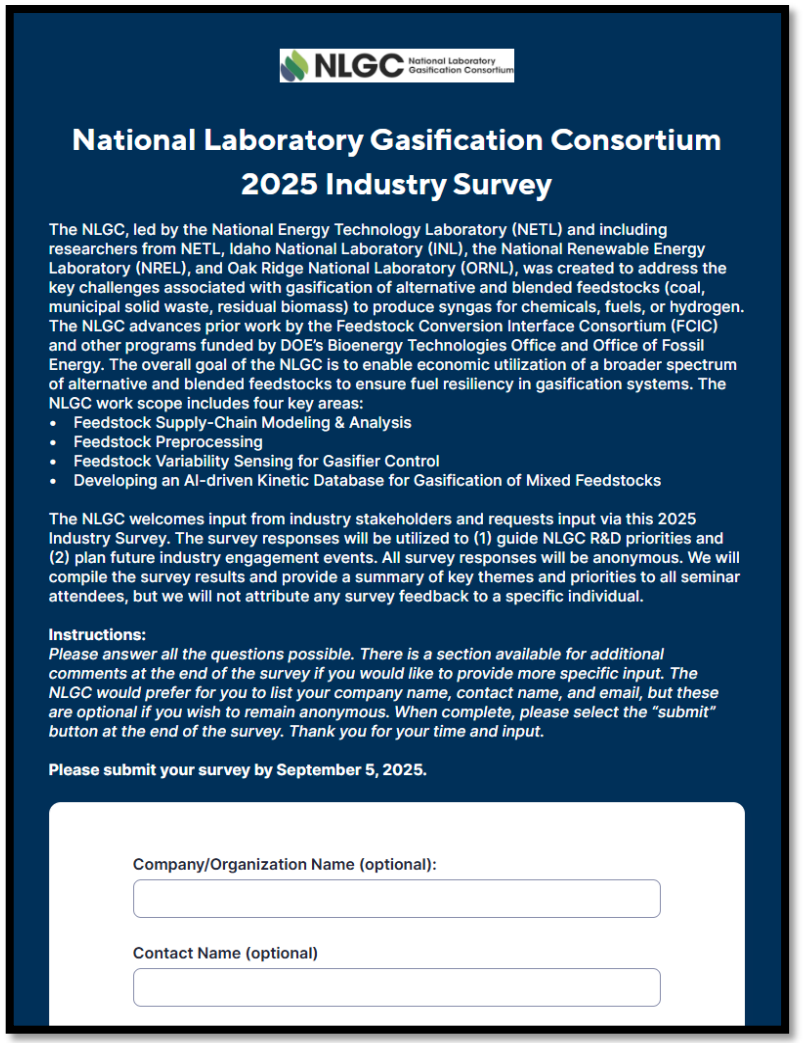


Conclusion and NLGC Industry Survey

NLGC National Laboratory Gasification Consortium

Provide your input to the NLGC via our Industry Survey today!

- Please fill out our initial Industry Survey
  - USEA to email survey after the Webinar
  - Also available at the NLGC USEA Website
- Please complete the survey by 9/5/25
  - Estimated 10-15 minutes to complete
- Survey responses will be utilized to:
  - Guide NLGC R&D priorities
  - Plan future industry engagement events
  - Ensure that we are focused on the critical needs of the gasification community



NLGC National Laboratory Gasification Consortium

National Laboratory Gasification Consortium
2025 Industry Survey

The NLGC, led by the National Energy Technology Laboratory (NETL) and including researchers from NETL, Idaho National Laboratory (INL), the National Renewable Energy Laboratory (NREL), and Oak Ridge National Laboratory (ORNL), was created to address the key challenges associated with gasification of alternative and blended feedstocks (coal, municipal solid waste, residual biomass) to produce syngas for chemicals, fuels, or hydrogen. The NLGC advances prior work by the Feedstock Conversion Interface Consortium (FCIC) and other programs funded by DOE's Bioenergy Technologies Office and Office of Fossil Energy. The overall goal of the NLGC is to enable economic utilization of a broader spectrum of alternative and blended feedstocks to ensure fuel resiliency in gasification systems. The NLGC work scope includes four key areas:

- Feedstock Supply-Chain Modeling & Analysis
- Feedstock Preprocessing
- Feedstock Variability Sensing for Gasifier Control
- Developing an AI-driven Kinetic Database for Gasification of Mixed Feedstocks

The NLGC welcomes input from industry stakeholders and requests input via this 2025 Industry Survey. The survey responses will be utilized to (1) guide NLGC R&D priorities and (2) plan future industry engagement events. All survey responses will be anonymous. We will compile the survey results and provide a summary of key themes and priorities to all seminar attendees, but we will not attribute any survey feedback to a specific individual.

Instructions:
Please answer all the questions possible. There is a section available for additional comments at the end of the survey if you would like to provide more specific input. The NLGC would prefer for you to list your company name, contact name, and email, but these are optional if you wish to remain anonymous. When complete, please select the "submit" button at the end of the survey. Thank you for your time and input.

Please submit your survey by September 5, 2025.

Company/Organization Name (optional):

Contact Name (optional)

Thank you for your interest in the NLGC!

- Following the Webinar, the USEA website will be updated to include presentation slides and a recording of the webinar
- Responses to questions from the chat (time permitting)
  - Opportunity to ask questions at the end of the Industry Survey

NLGC
National Laboratory
Gasification Consortium

Thank You

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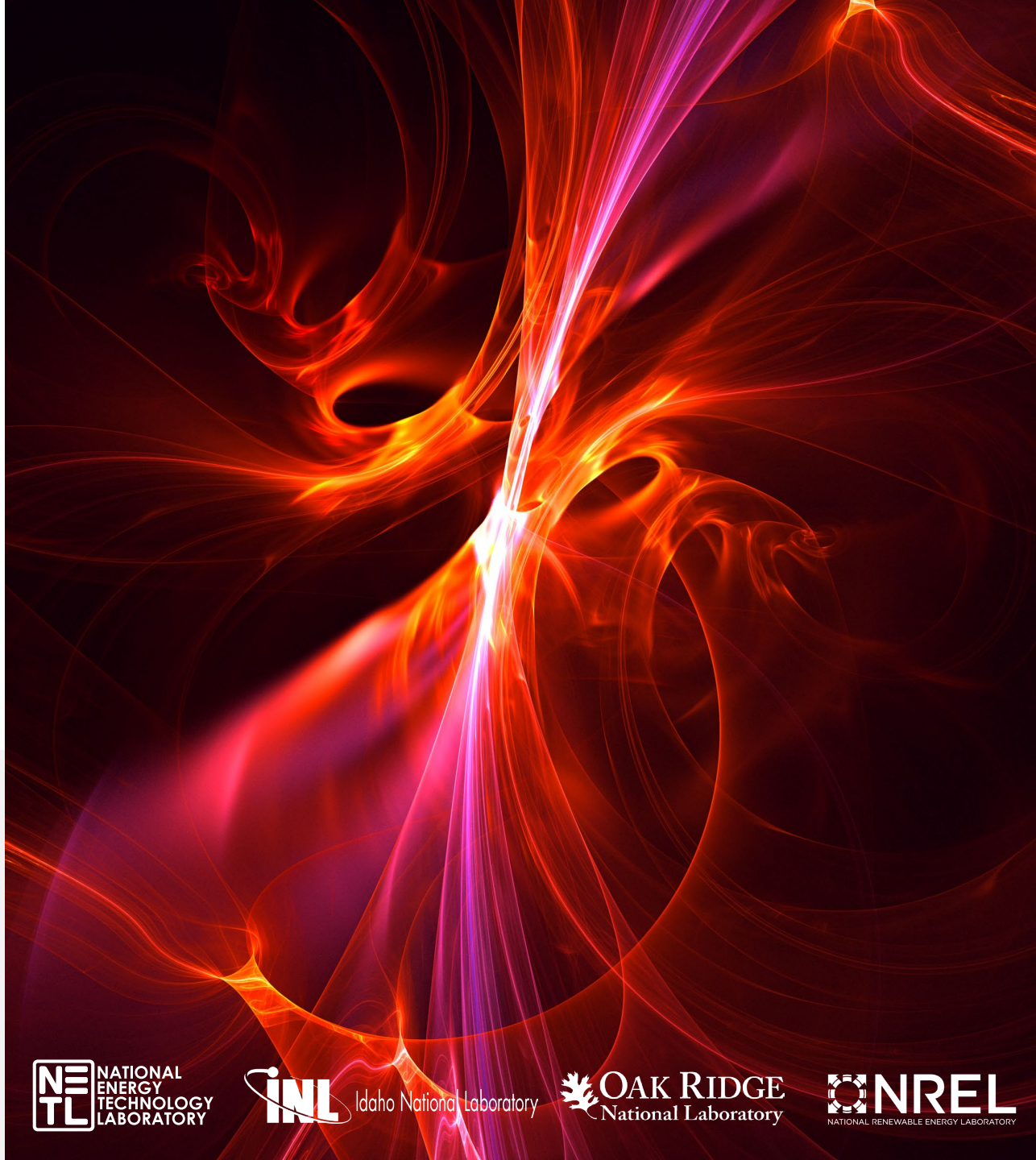

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NATIONAL ENERGY TECHNOLOGY LABORATORY
Idaho National Laboratory
OAK RIDGE National Laboratory
NREL NATIONAL RENEWABLE ENERGY LABORATORY