Application of Data-Informed Simulation for Accelerating Biofuels and Alternative Feedstock Utilization

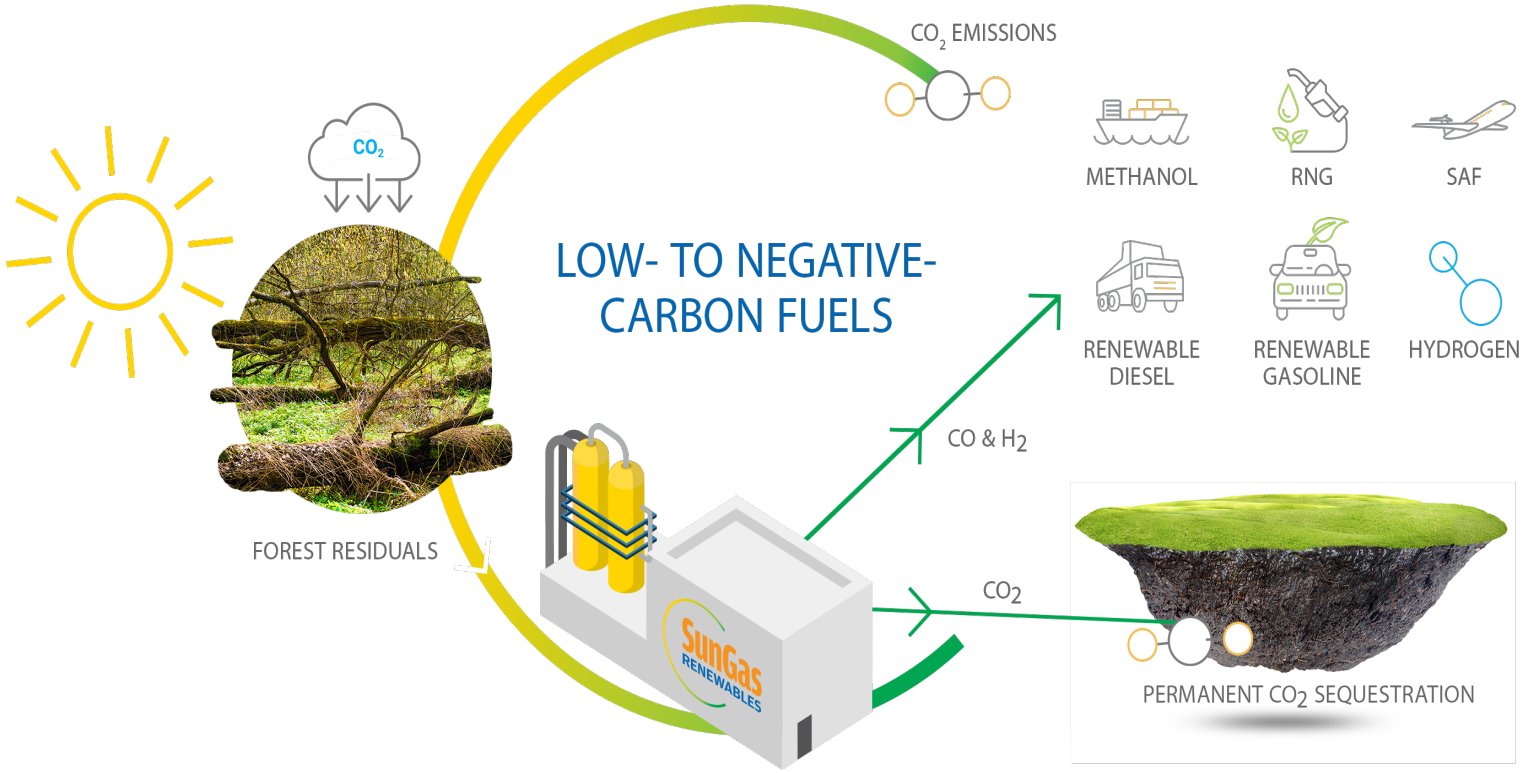
Peter Loezos, Bryan Tomsula – CPFD Software Inc.

Andrew Kramer, Shrinivas Lokare – SunGas Renewables Inc.

TC Biomass Conference, Chicago, IL

September 10-12, 2024

SunGas' Sustainability Pathway

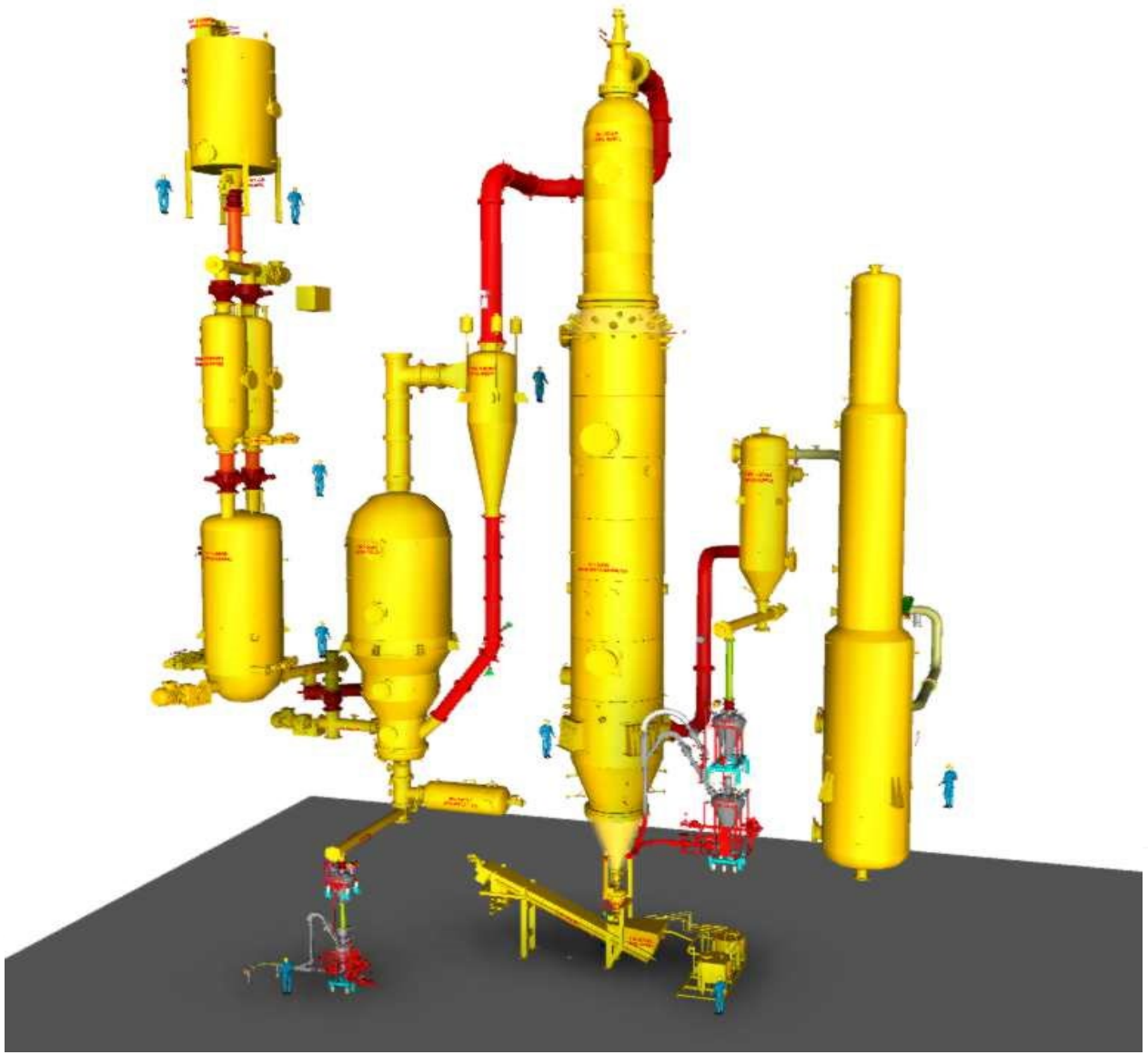


The natural air capture (NAC) approach to achieving carbon reduction TODAY

SunGas Proven Technology Embodied in the System 1000™ Offering Enables –

- Renewable Energy Production in Multiple Energy Segments
- Production of Low and Negative Carbon-Intensity Energy Products
- Qualification for Renewable Energy Incentives and Credits
- Criteria Pollutants Reduction by 99% Compared to Biomass Power Plants

The S-1000 Product



Gasifier

- Versatile feedstock capabilities
- Unique Jet & Grid design creates optimum conditions for fast reactions and uniform temperature distribution

Feedstock Handling System

- Lock-hopper based design – crossing pressure barrier
- Flexible feed options – screw-feeding or pneumatic feeding

Ash Handling System

- Removes and cools bed and filter ash
- Conveys to silo storage pneumatically

Tar Reformer

- Complete reforming of all tars
- Immune to contaminants in feedstock

Syngas Cooler

- Capable of operating slagging/non-slagging conditions
- Self-cleaning design of heat transfer components

Syngas Filter

- High efficiency (99.9%) of removing fines
- Surface modified sintered metal provides extended life

Syngas Scrubber

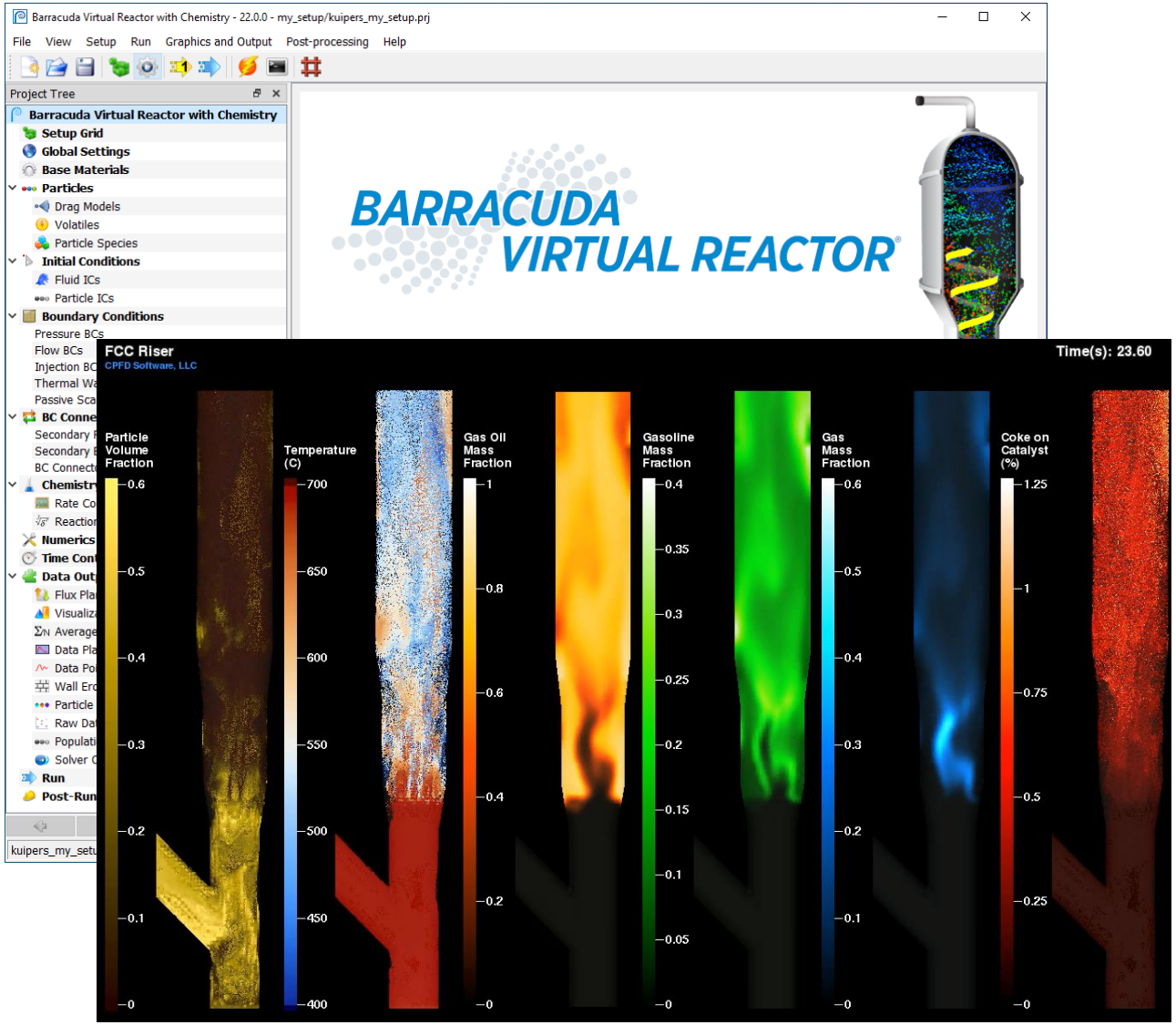
- Primary gas cooling and moisture removal
- Trace contaminate removal, HCl, NH3

SunGas RENEWABLES™

cpfd

CPFD Introduction

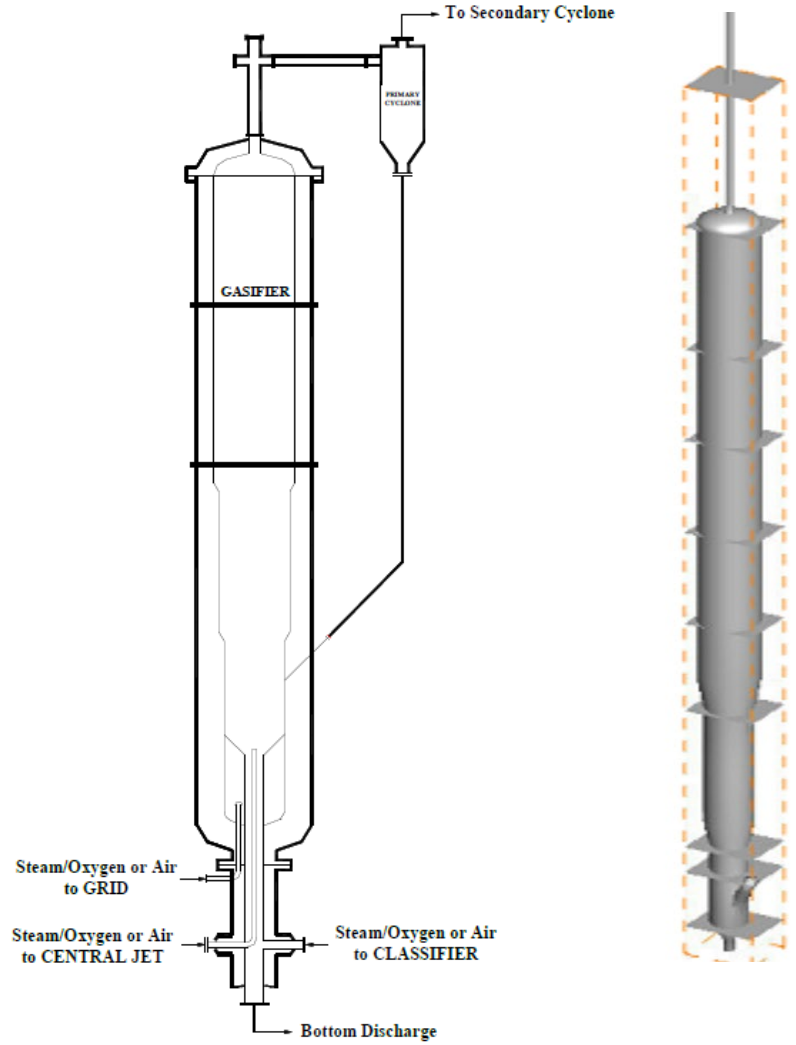
- Physics-based engineering software package
  - Virtual Reactor is the only commercial software package focused specifically on chemically-reactive fluid-particle flow at large scale
- Software Licensing
  - Use Virtual Reactor in-house
  - Single site and global enterprise licensing available
  - On-premise and cloud-served licensing
- Services
  - Project-based or broader collaboration
- Training and Technology Transfer
  - New user training, custom/advanced training, QuickStart and general technology transfer
- Application Areas
  - FCCU / Refining, Petrochemicals, Gasification, Materials and Chemicals, Power Generation, Clean Technologies



FCCU Riser Feed Injection Zone

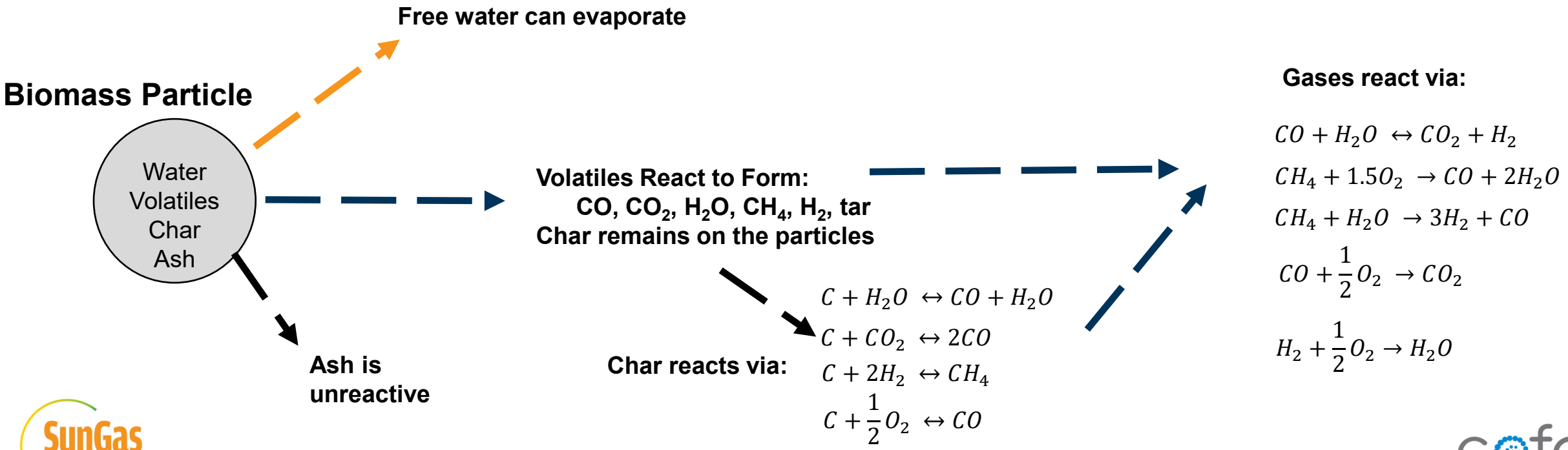
Project Overview

- Staged approach to develop a commercial scale model of the Sungas gasifier
- Initial model developed based on U-Gas pilot plant data
  - Provides proof of concept for model development
  - Test cases based on various pilot plant operating conditions
  - Utilized for scale up design
- Subsequent models to be developed focusing on modifications to the reaction / kinetic pathways
  - Feedstock dependent devolatilization
  - Tar reforming
  - Kinetic dependence on bed material composition



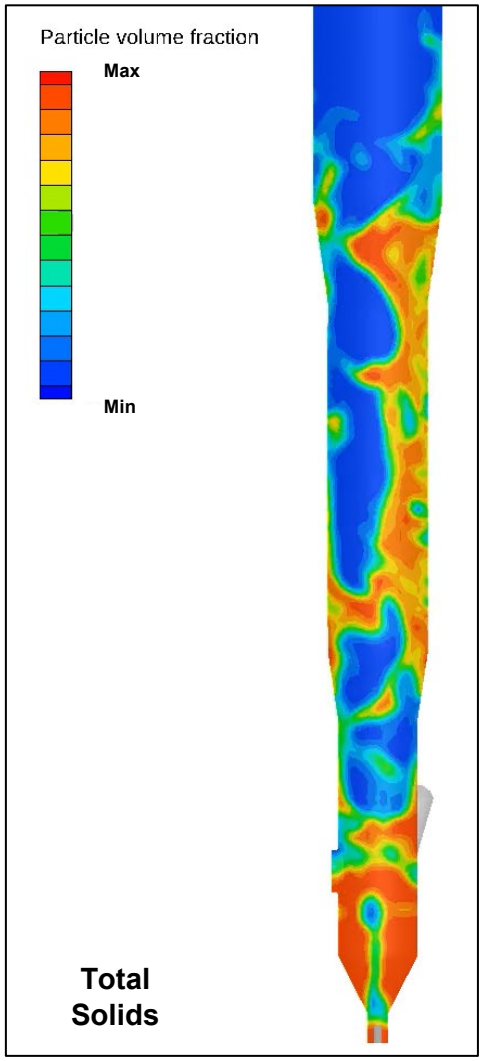
Model Setup

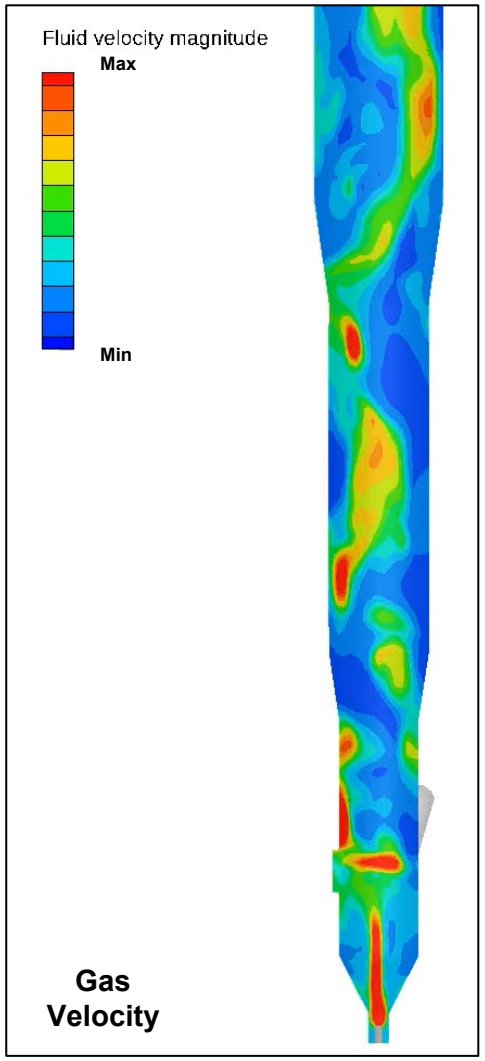
- Extents of model are focused on the gasifier vessel
- Kinetic network implemented based on experimental data coupled with literature gasification kinetics
- Plug flow model was developed to allow for regression of kinetic expressions across the pilot plant operating conditions

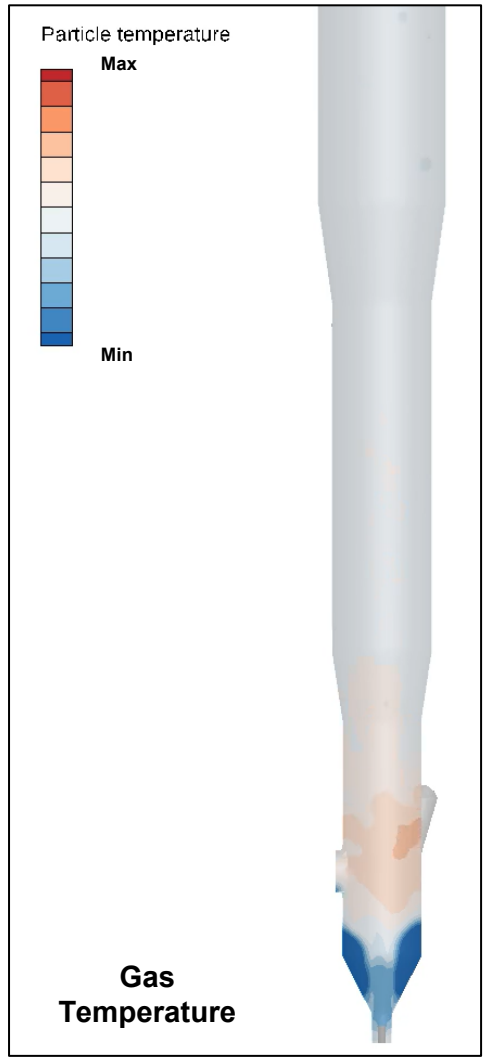


Results

- Base case model was developed utilizing Sungas pilot plant gasifier data
- Hydrodynamics and temperature profile validated against experimental data sets
- Results provide valuable insight into the impact of hydrodynamics and mixing behavior

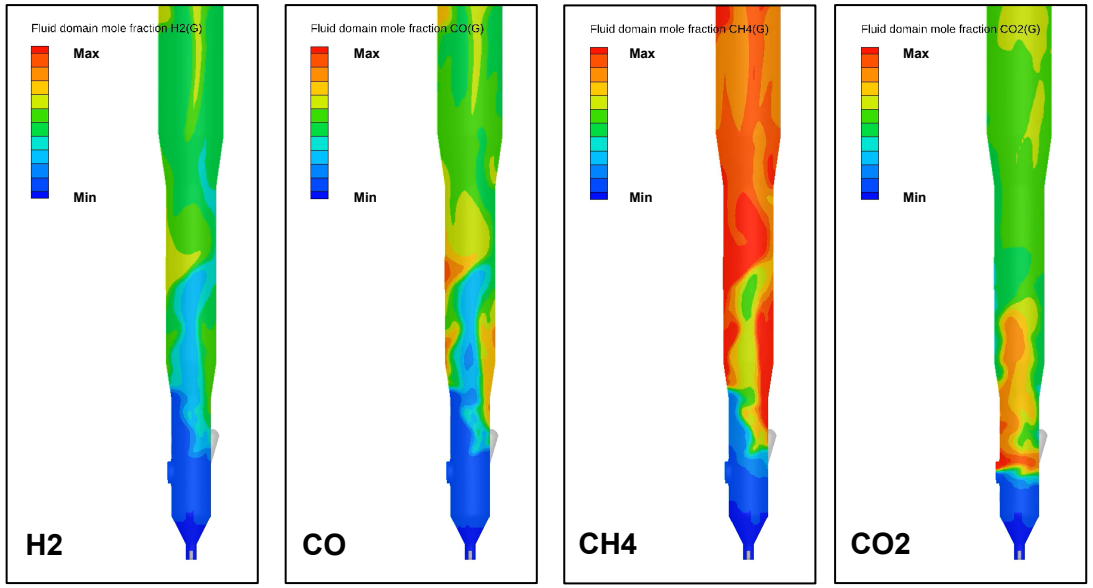


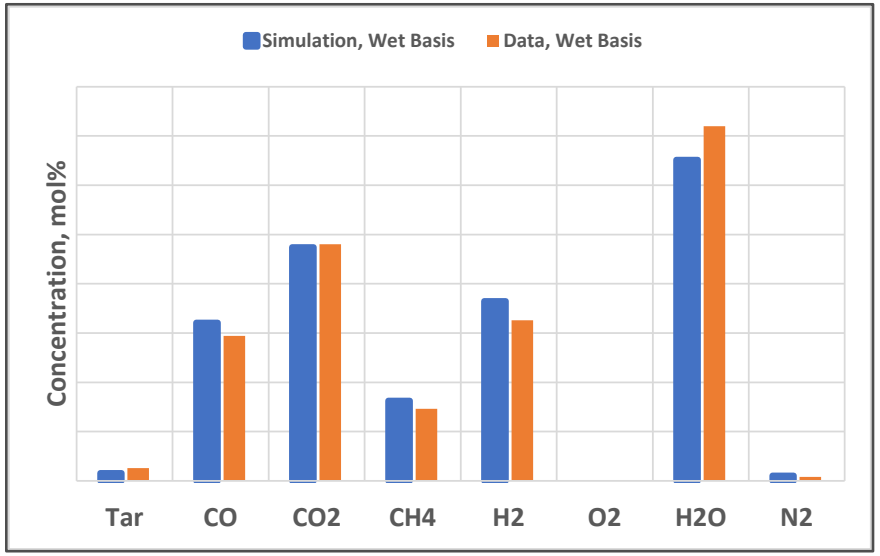


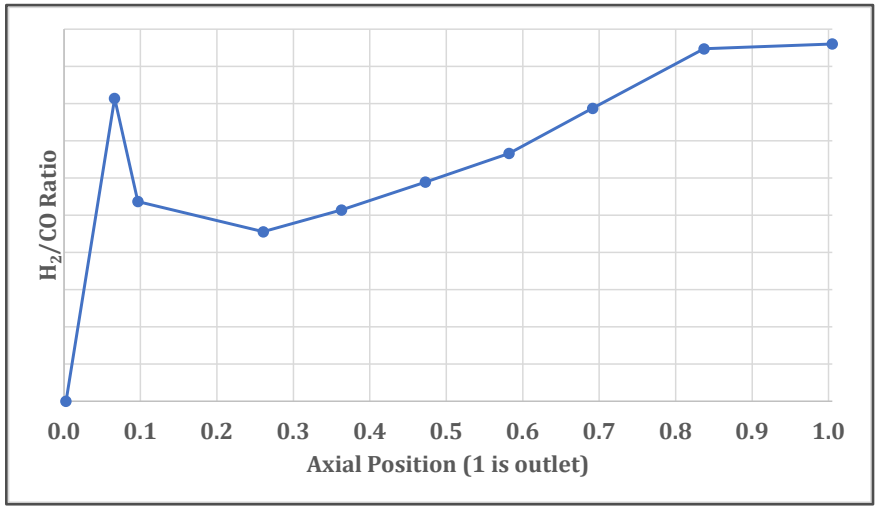


Results

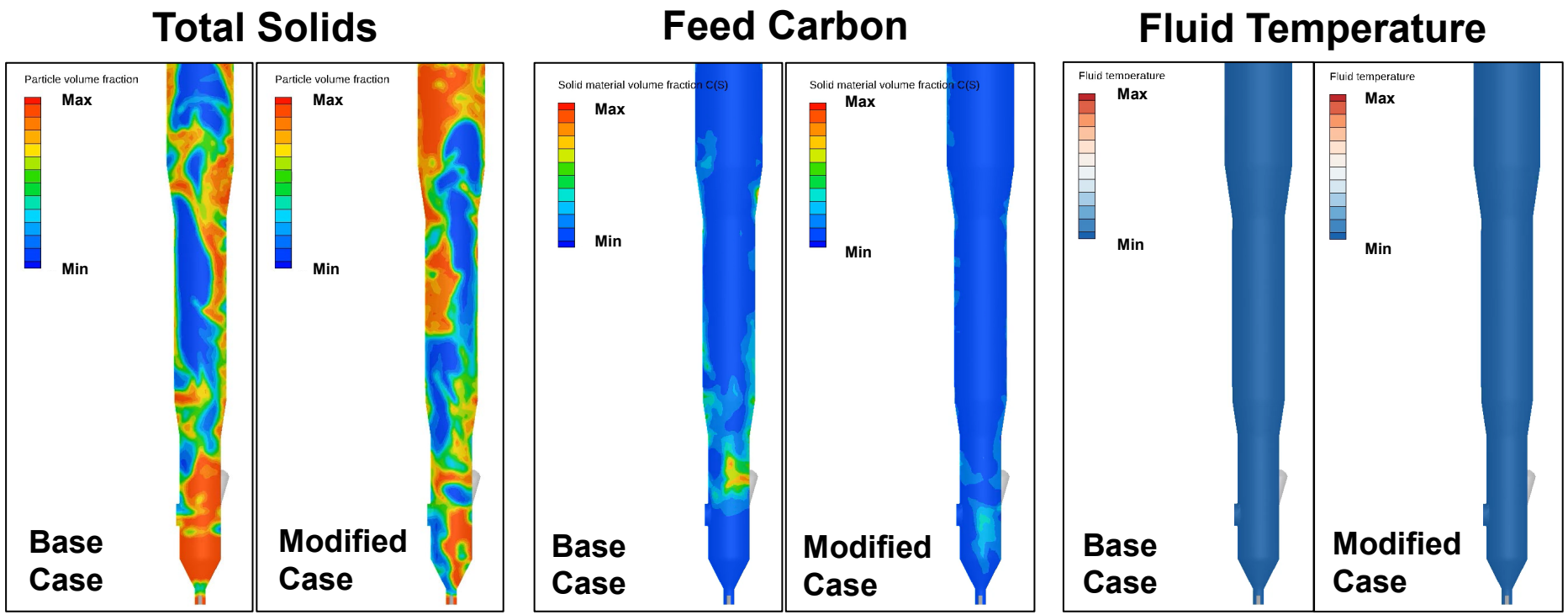
- Model results correlate well with experimental data
- Axial gas compositions are able to be monitored and reported
- Allows for optimization of reactor operating conditions and valuable insight into gasifier performance.





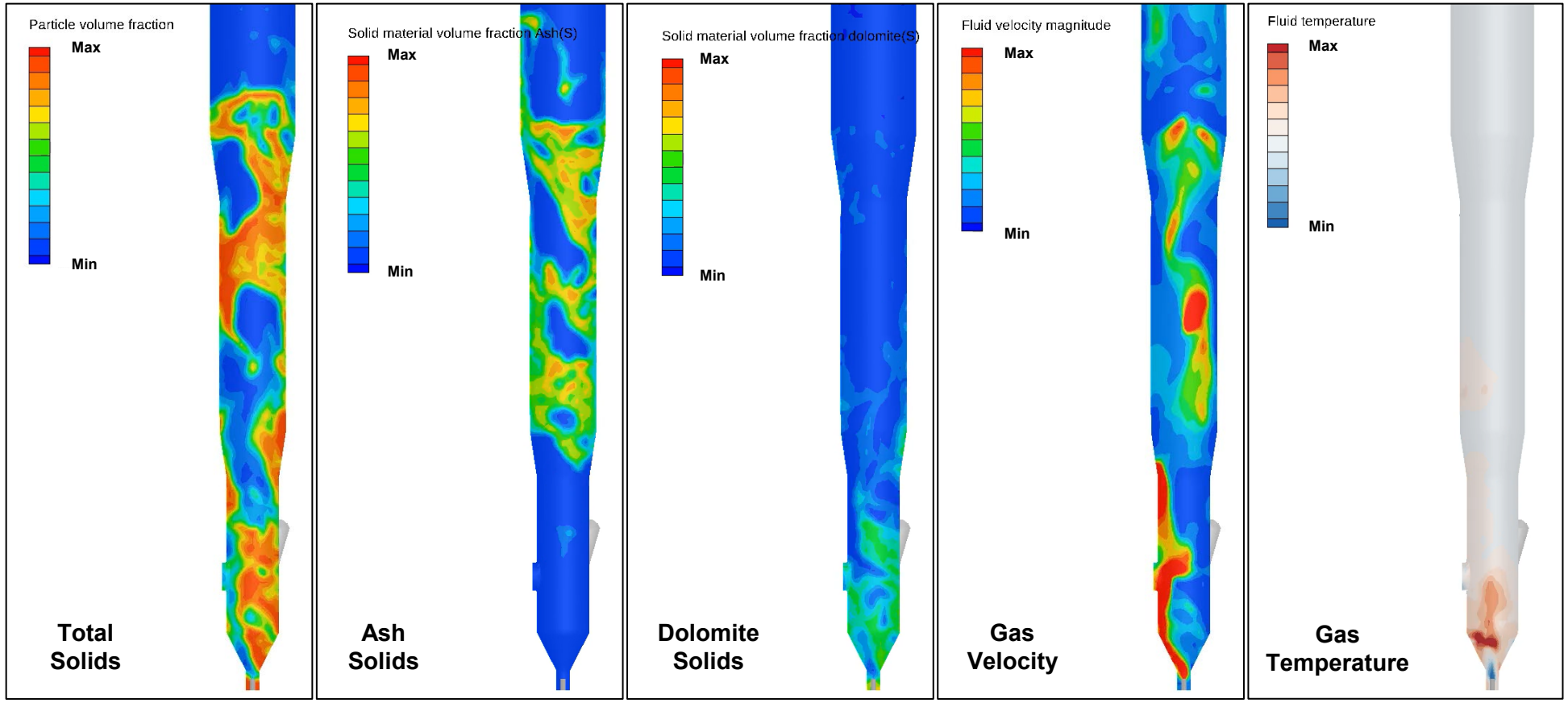


Model Insights



- Impact of bed material size distribution was studied
- Hydrodynamic behavior from transition to Geldart Group B from Group D is captured in the model

Model Insights



- Enhanced mixing is observed in the modified gas with bed material consisting of Group B type solids

Conclusion

- A CPFD model was developed for the U-Gas pilot plant gasifier
- Data based modeling approach was utilized for implementing reaction network and hydrodynamic models
- Modeling based approach coupled with sound engineering practices aid in assessing impact of variations in key operating parameters, such as pressure, throughput, feed type, etc.

Thank You