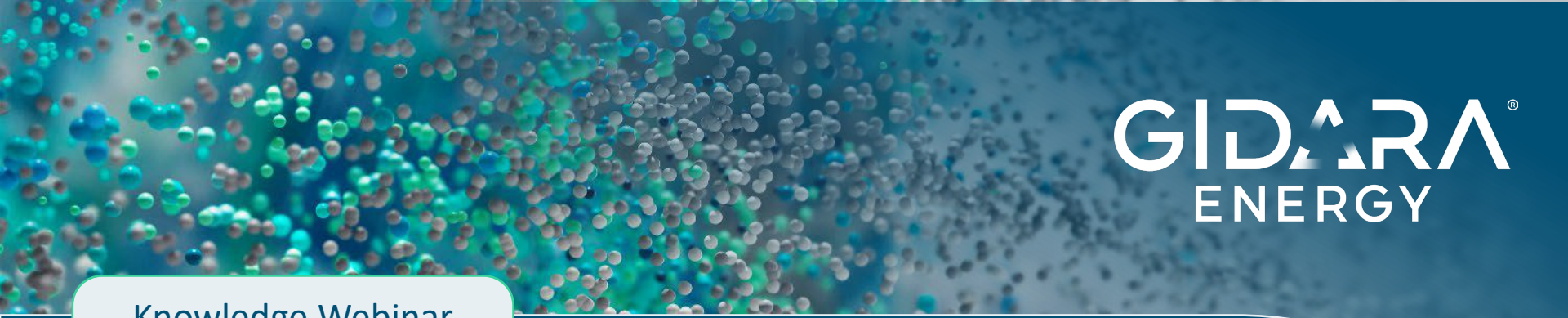


GIDARA® ENERGY

Knowledge Webinar

Breaking Feedstock Barriers with HTW® Gasification in the Race to Net-Zero

3rd December 2024

SPEAKERS

Dr. Niek de Nooijer
| Product Development Manager

ir. Pim de Vries
| Waste Subject Matter Expert

Prof. Dr. Dobrin Toporov
| Gasification Expert

Beyond Economics: The Real Drivers

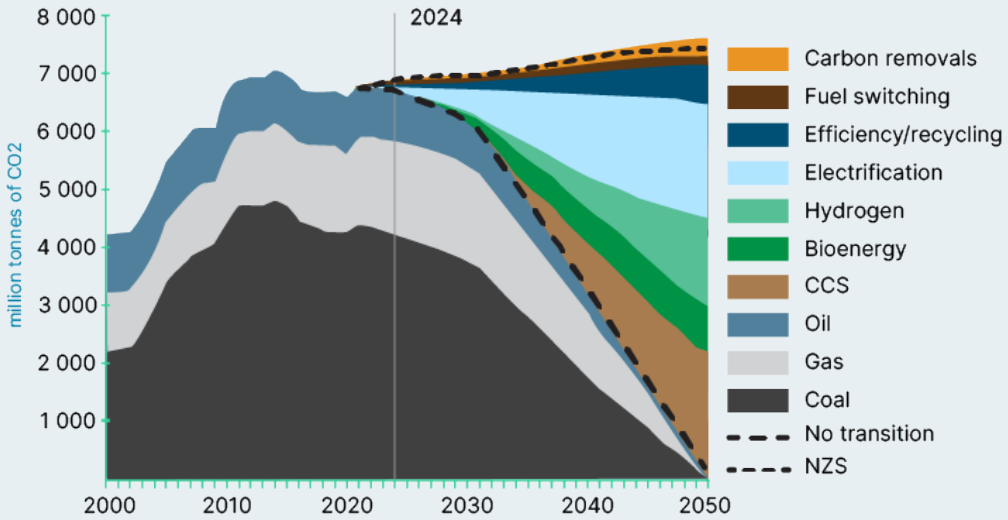
Destination - Net Zero

GIDARA ENERGY

CO_2 abatement in industries by technology

Notes: NZS = net zero scenario; CCS = carbon capture and storage

Source: BloombergNEF



Immediate Action Is Imperative!

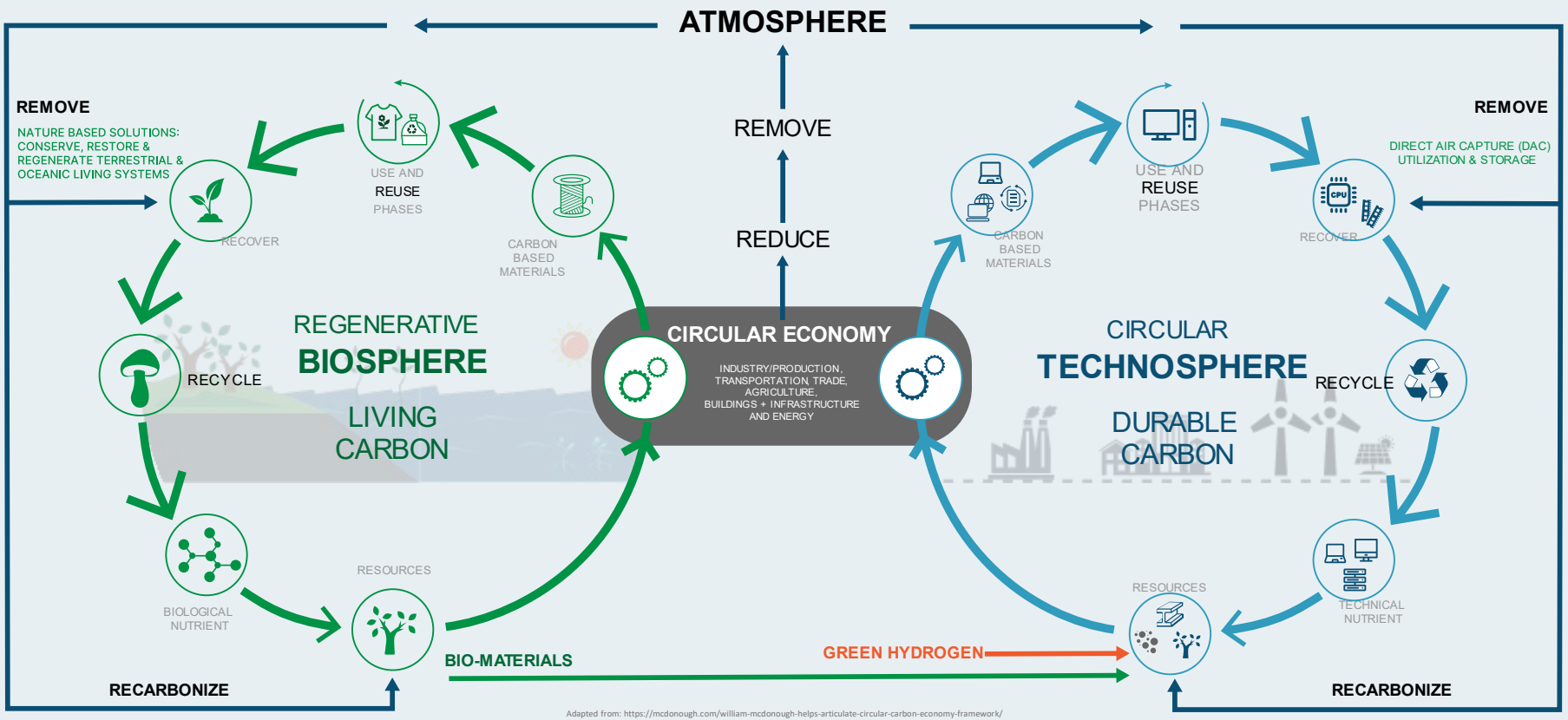
Main Drivers

- **Strategic Net-Zero Commitments**
- **Market Transformation**
- **Government Incentives**
- **Policy Intervention**

Circular Carbon Economy

From Linear Waste to Regenerative Systems

GIDARA ENERGY



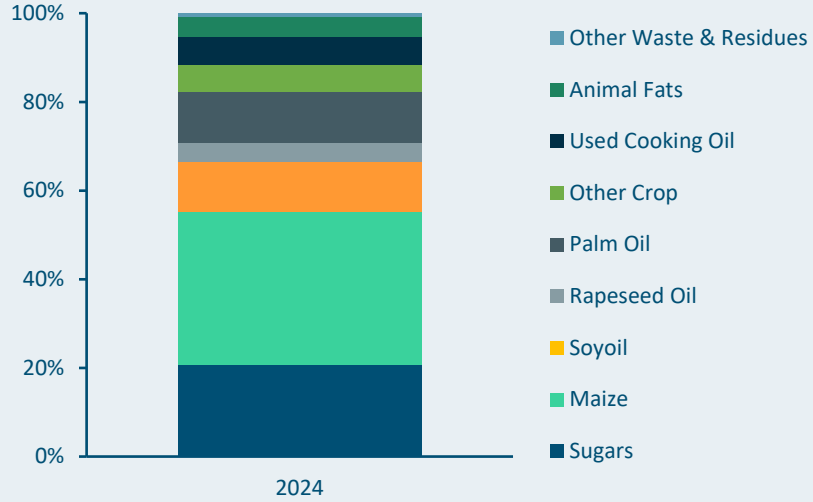
Adapted from: https://mcdonough.com/william-mcdonough-helps-articulate-circular-carbon-economy-framework/

Current Feedstock Limitations

What meets the targets today?

Global Biofuel Production Per Feedstock for 2024

Source: International Energy Agency. (2022)



Limited by:

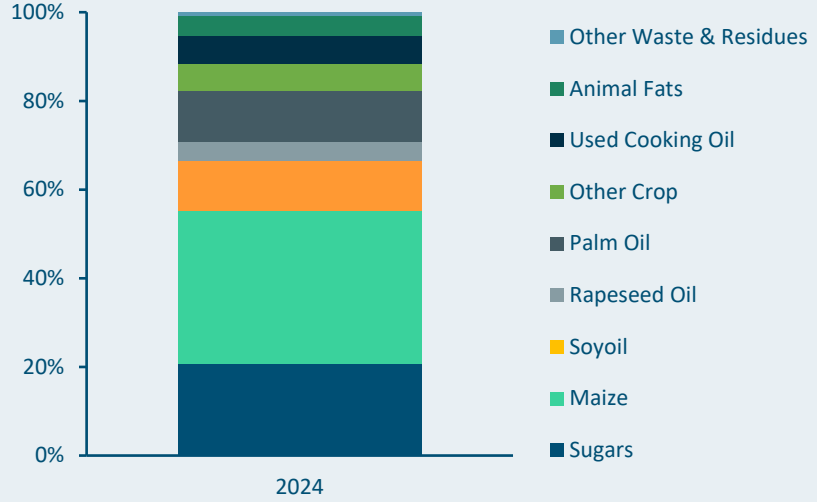
- Availability
- Competition with Food Production
- Carbon Emissions from Land-Use Changes

Current Feedstock Limitations

What meets the targets today?

Global Biofuel Production Per Feedstock for 2024

Source: International Energy Agency. (2022)

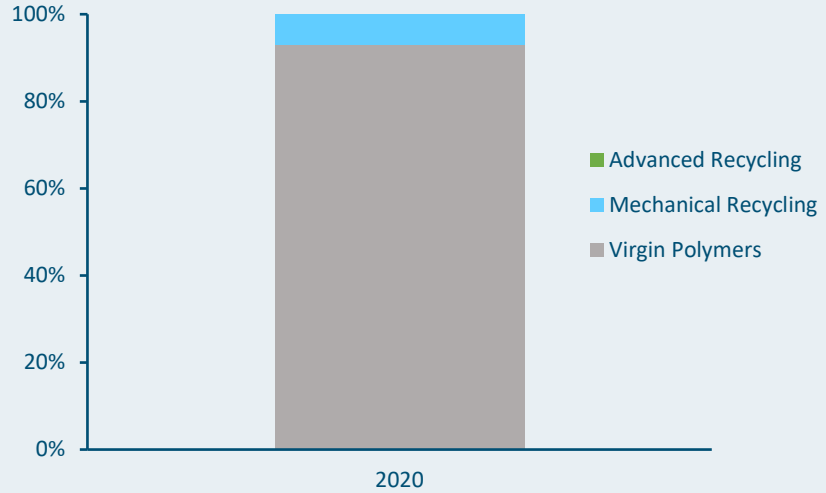


Limited by:

- Availability
- Competition with Food Production
- Carbon Emissions from Land-Use Changes

Global Polymer Supply for 2020

Source: McKinsey & Company. (2021)



Limited by:

- Downcycling
- Sorting limitations
- Blending limitations of mechanical recycled polymers

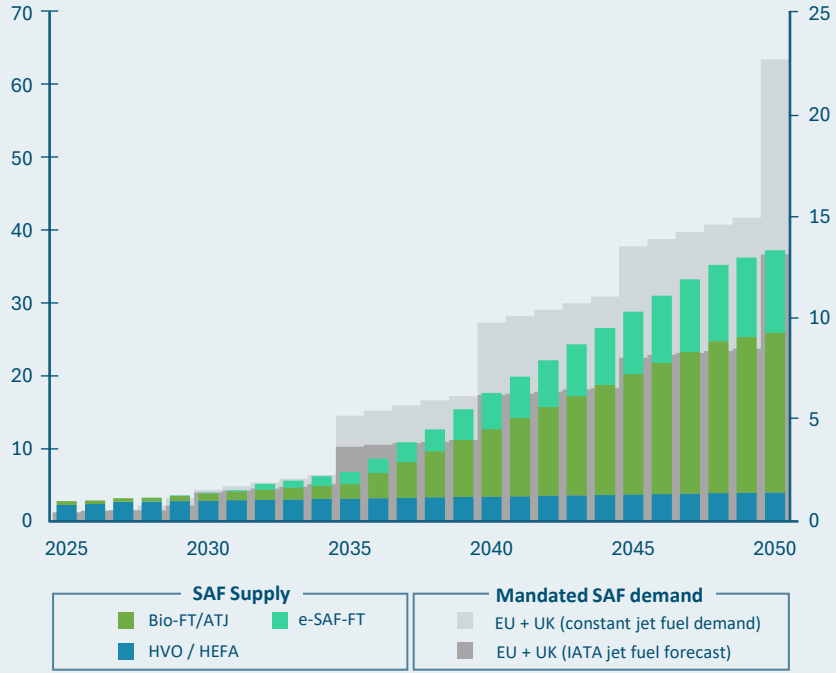
Future Feedstock Outlook

Challenges brought by limited feedstocks?

European SAF capacity vs. mandated SAF demand to 2050

SAF capacity EU + UK (Mt)

Source: SkyNRG annual report 2023



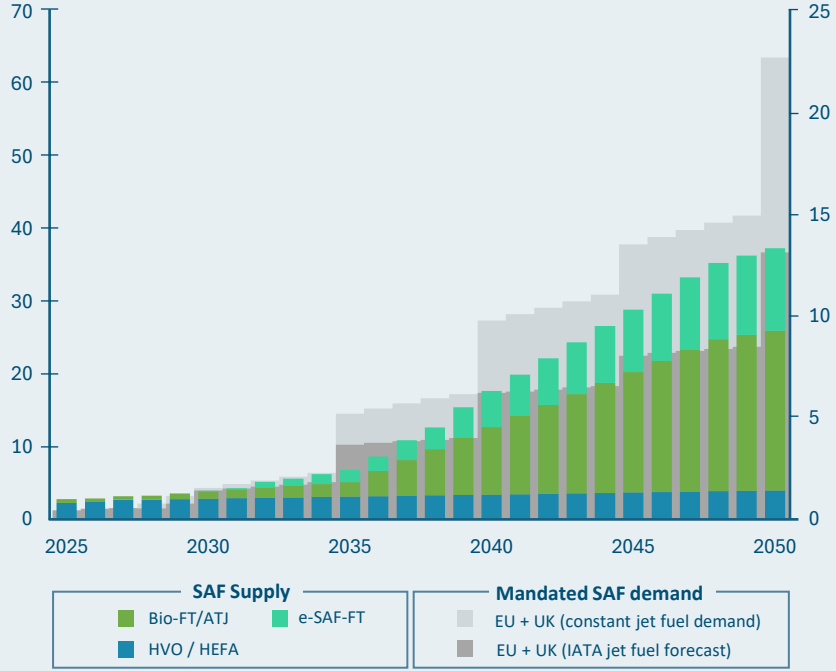
Future Feedstock Outlook

Challenges brought by limited feedstocks?

European SAF capacity vs. mandated SAF demand to 2050

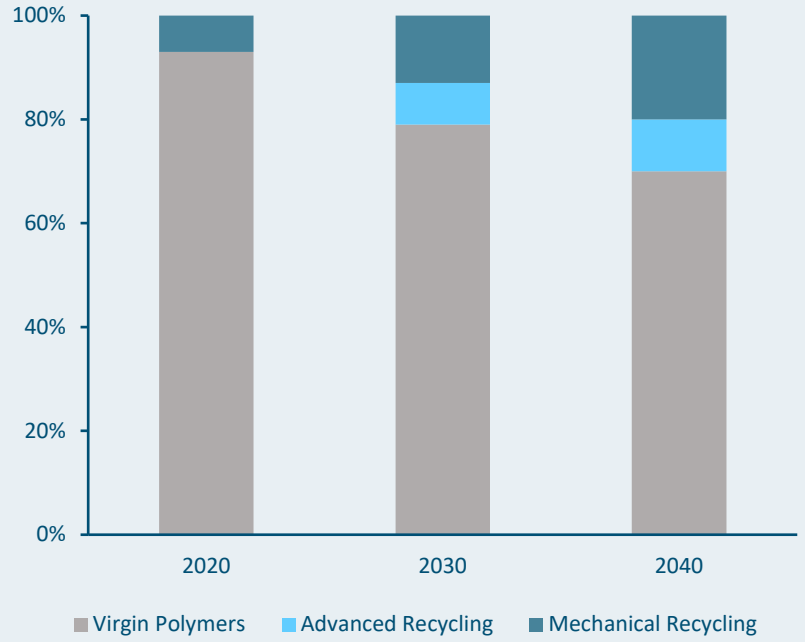
SAF capacity EU + UK (Mt)

Source: SkyNRG annual report 2023



Global Forecasted Polymer Demand

Source: McKinsey & Company. (2021)




WHAT IF WASTE BECAME FEEDSTOCK?

The Need for Innovative Approaches

Our Solution - HTW® Gasification

Solid Waste

Forestry Waste

Agricultural Waste

BIOMASS WASTE

MSW

Construction & Demolition

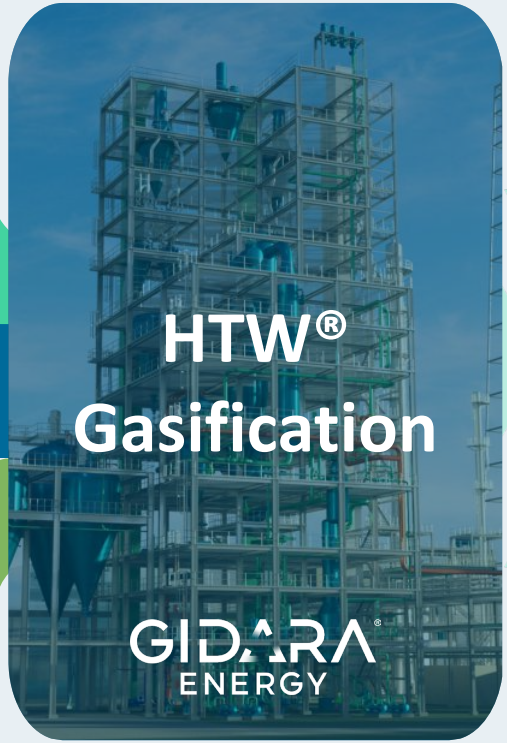
Industrial Waste

MIXED WASTE

Mixed Plastics

Hard to Recycle Plastics

RECYCLED CARBON



Sustainable Chemicals

Transportation & Maritime Fuels

Sustainable Aviation Fuel (SAF)

Hydrogen

Heat & Energy

From Waste to Feedstock

Preparing for HTW® Gasification

Forestry Waste

Agricultural Waste

MSW

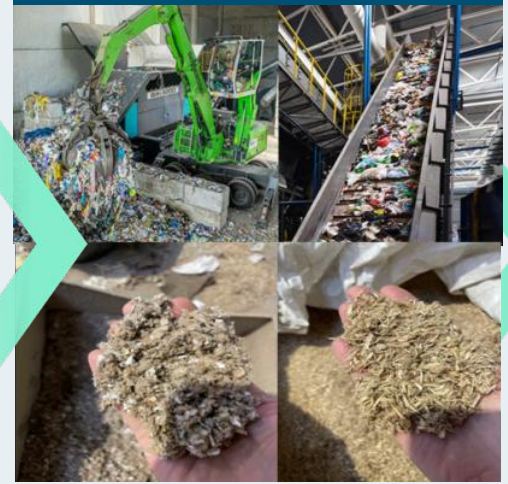
Construction & Demolition

Industrial Waste

Mixed Plastics

Hard to Recycle Plastics

Shredding & Sorting



**Depending on type of feedstock it can vary in steps and complexity*

Drying

Pelletizing

From Waste to Feedstock

Preparing for HTW® Gasification

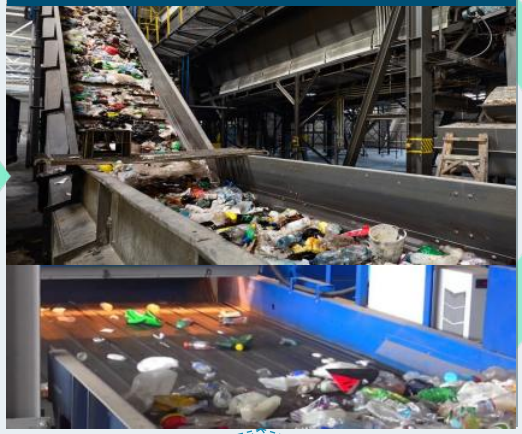
MIXED WASTE

Industrial Waste Type

MUNICIPAL SOLID WASTE

Household black bag garbage type

Sorting & Separation



Easily Recyclable Plastics → **Mechanical Recycling**

Metals & Inert → **Mechanical Recycling**

Separable Organic Fraction → **Digestors**

Hazardous Materials → **Disposal**

Mixed Plastic Waste

Mixed Plastics that cannot be mechanically recycled

Secondary Waste Fuels

Refuse Derived Fuel (RDF)

Material that cannot be used for recycling purpose - partly biogenic

Solid Recovered Fuel (SRF)

Standardized form of RDF

Drying & Pelletizing

Balancing Feedstock Requirements

Key Parameters for Efficient Gasification

GIDARA ENERGY

Feedstock Requirements

PHYSICAL REQUIREMENTS

FEEDSTOCK SPECIFICATIONS

- 8-12 mm diameter pellets
- 10-12% Moisture content

PELLETIZATION BENEFITS

- Homogenization and Flowability
- 200-400% Higher handling efficiency
- Simplified site logistics
- Global market tradability
- Up to 200% higher self-ignition temperature

CHEMICAL REQUIREMENTS

CHEMICAL COMPOSITION SPECIFICATIONS

- Carbon - Hydrogen – Oxygen Content
- Fixed carbon (FC)
- Heating Value
- Ash Properties

BENEFITS

- Results in high yield and quality of syngas
- Contributes to an efficient system design
- Ensures system flexibility with feedstocks

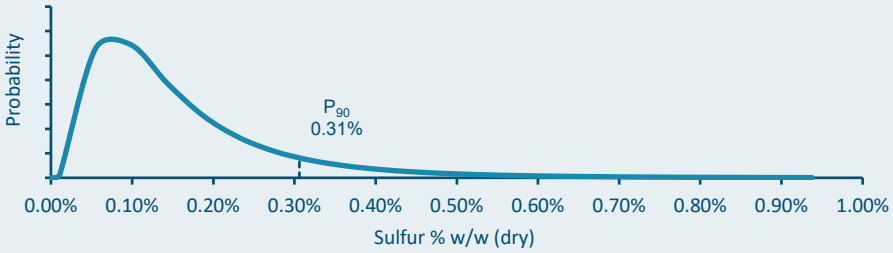
Feedstock Flexibility with HTW®

Strategies for Handling Composition Variations

GIDARA ENERGY

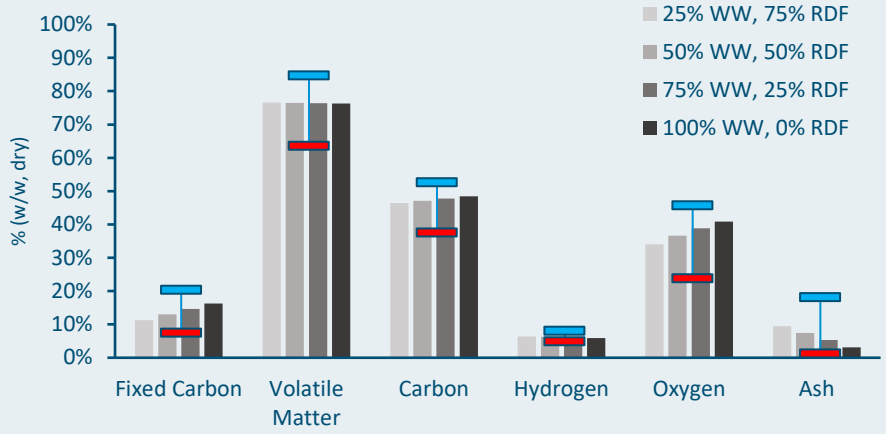
Our database of feedstock compositions helps to:

- Predict composition probability distributions
- Define realistic design boundaries
- Optimize for feedstock flexibility

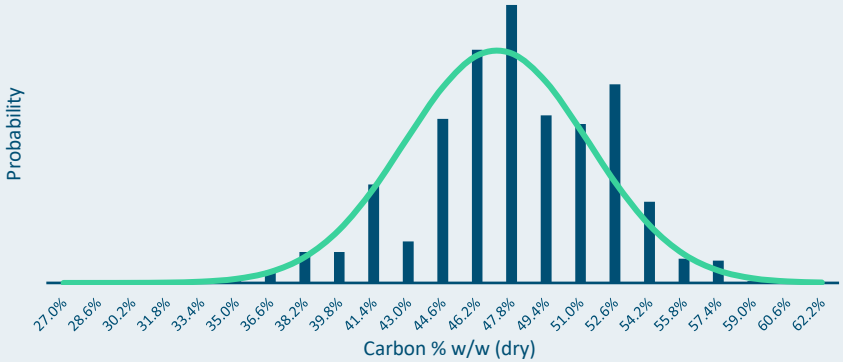


Probability of Sulfur Content in Feedstock

Feedstock Composition Variation for MSW and Waste Wood (WW) mix



Normal Distribution of Carbon Content in Feedstock



Balancing Feedstock Requirements

Key Parameters for Efficient Gasification

GIDARA ENERGY

CHEMICAL REQUIREMENTS

CRITERIA & DESIGN IMPACT

IMPACTS THE SYNGAS COMPOSITION

- Carbon - Hydrogen - Oxygen

IMPACTS DESIGN OF THE SYSTEM

- Fixed carbon (FC)
- Heating value
- Ash content
- Ash melting

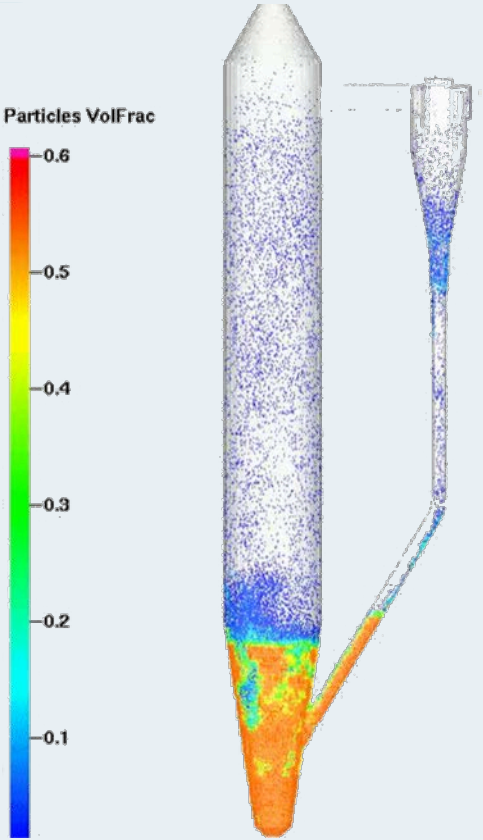
LABORATORY TESTS

ULTIMATE ANALYSIS:

- Carbon, Hydrogen, Oxygen, Nitrogen, Sulfur.

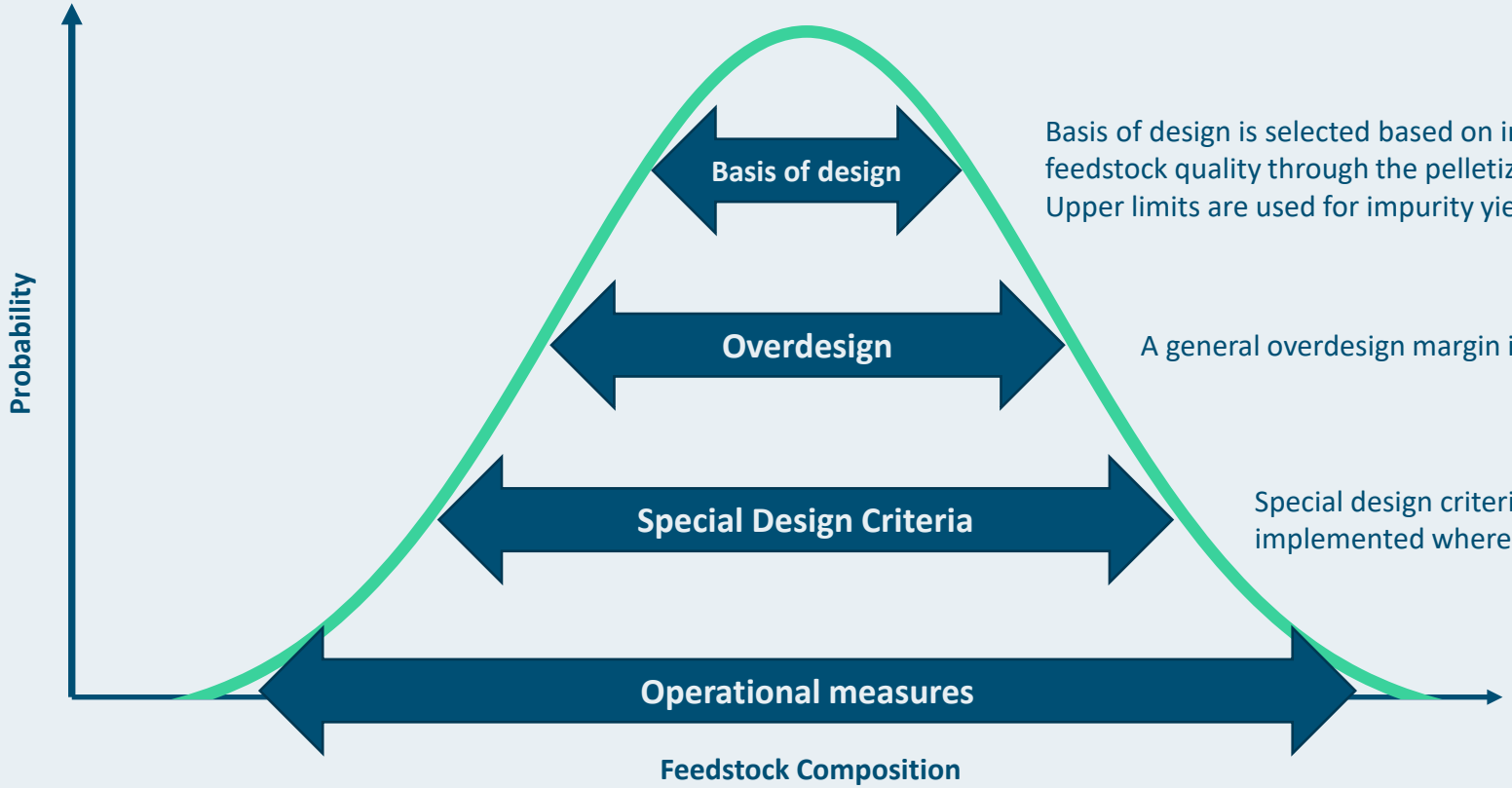
STANDARDIZED ANALYSES:

- *Proximate Analysis:* Moisture, Ash, Volatiles, Fixed Carbon.
- *Heating Value:* Gross and Net Calorific Value.
- *Ash Melting Behavior:* SST (Softening), IDT (Initial Deformation), FT (Flow Temperature) in reduced atmospheres.



GIDARA Team Dealing With Variability

Strategies for Handling Composition Variations



Basis of design is selected based on improved feedstock quality through the pelletizer unit. Upper limits are used for impurity yields to gas.

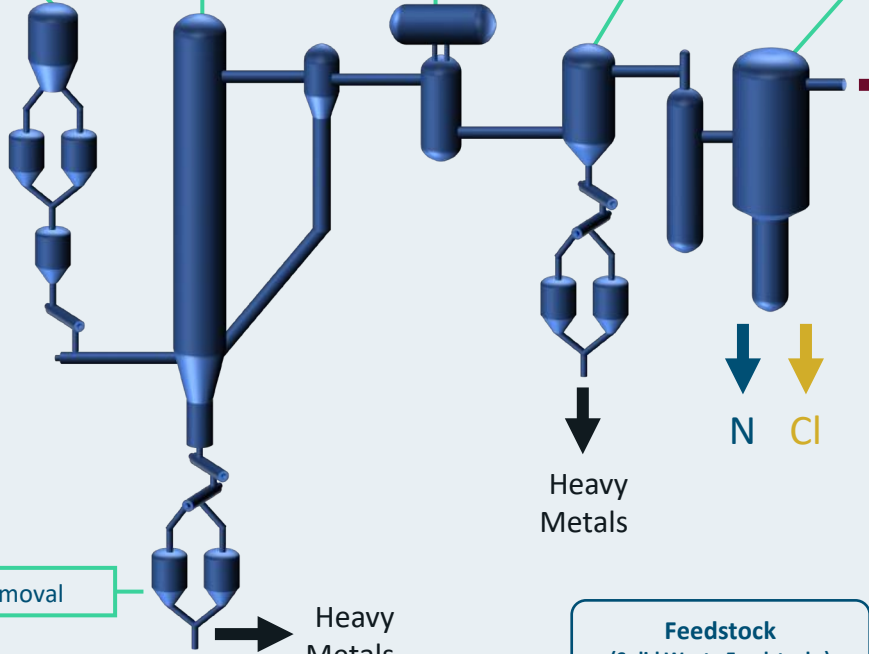
A general overdesign margin is applied.

Special design criteria are implemented where necessary.

HTW®'s Impurity Management

Tackling Contaminants Across the Process Chain

GIDARA ENERGY



Syngas

- ✓ Chlorine free
- ✓ Dust free
- ✓ Particle free
- ✓ Tar free

Feedstock (Solid Waste Feedstocks) → **Syngas** (CO, H_2, CO_2) → **End Products** (Energy, Chemicals, Fuels)

Intrinsic Feedstock Features

Adapting to Diverse Inputs for Consistent Outputs

- **PELLETIZATION**

milling to small particles improve homogenic mixture, pellets assure flowability during pressurization

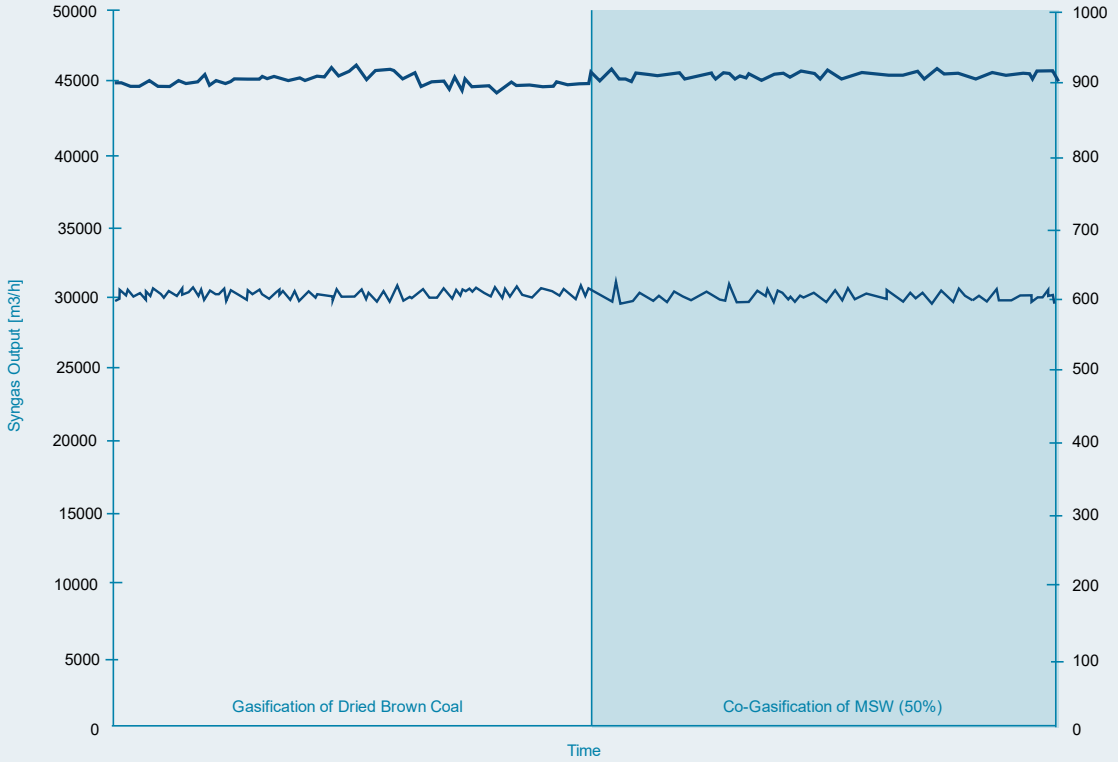
- **HIGH CARBON VOLUME**

in the fluidized bed, acts like a fly-wheel for carbon

- **LONG RESIDENCE TIME**

assuring full carbon conversion and breakdown of heavy molecules.

Source: Adlhoch, W., Sato, H. et. al., (2000). High-Temperature Winkler Gasification of Municipal Solid Waste. 2000



Waste CAN Become Feedstock!

Waste is Your Next Feedstock

GIDARA's deep understanding of feedstock compositions enables reliable conversion of diverse waste streams into valuable products

Beyond Traditional Limitations

While conventional feedstocks face constraints in availability and sustainability, GIDARA's expertise unlocks the vast potential of waste materials

Mastering Feedstock Variability

Our extensive database and processing experience ensure consistent performance despite varying waste compositions, from MSW to hard-to-recycle plastics

From Complex to Controlled

GIDARA's proven pelletization approach transforms unpredictable waste streams into standardized, high-quality feedstock with 200-400% higher handling efficiency

HTW® - Proven Performance, Unlimited Potential

Superior Feedstock Flexibility

- Efficiently handles diverse waste streams, including hard-to-recycle plastics and municipal solid waste
- Extensive database of feedstock compositions enables optimal process design

Proven Technology:

- Result of lessons learned through 10+ years commercial scale experience
- Over 600 million EUR invested in development

Versatile Applications

- Syngas offers flexibility to downstream conversion
- Unlocking waste potential to sustainable chemicals and fuels

Our Technology Available For You

GIDARA ENERGY

Licensing

- Conceptual study
- Feasibility study
- Standard License and basic engineering, incl prop. equip.
- Start-up support & personnel training, performance guarantee test supervision, annual health check

Gasification Island

Sustainable Fuel & Chemical Facility

Interested in working with us?

Contact us via:
info@gidara-energy.com
gidara-energy.com

GIDARA® ENERGY