# Feedstocks for Catalytic Hydrothermal Gasification

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# Overview of Gasification Feedstocks

- **Feedstock is any organic material made into slurry**
  - Water carries the solids, and is also used in reactions
- **Solids in slurry can be between 1% and 40%, but optimum range is between 10% and 20%**
  - Feedstocks in this range flow well, can be pumped easily, and allow for better sizing of machinery
- **Can gasify woody materials, but they are generally too expensive to make into slurry**
- **Particle size for slurry should be less than 300 µm (microns), ideally less than 100 µm**

# What A 10% Biomass Slurry Looks Like

# Types of Feedstocks

- **Many wet feedstocks are either nuisances, or problems, or are costly to handle or remove**
- **Such feedstocks are often available free, or (better yet) will pay for removal**
- **Many wet feedstocks originate or are processed at facilities which can readily use the output gas either for heat or for electricity on-site**

# Types of Feedstocks

- **Wet biomass such as aquatic growth**
- **Wastewater solids and animal waste**
- **Food processing wastes**
- **Biofuel production "bottoms"**
- **Water remediation growth**

***Note: Each of these is described further in the following slides***

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# Wet Biomass (Aquatic Growth)

- **Aquatic plants include macroalgae, microalgae, floating plants, and marsh plants**
  - Macroalgae (seaweeds) are marine species such as kelp
  - Microalgae are algae, cyanobacteria, and diatoms
  - Floating plants are water hyacinths, duckweed, azolla
  - Marsh plants include cattails, reeds, and cordgrass
- **In the near future, best choices are macroalgae, certain microalgae, and water hyacinths**

# Wastewater Solids

- **Wastewater solids are separated from the water flow in sanitary sewer systems, then thickened**
- **These materials are currently treated in various ways before ultimate disposal**
- **CHG can provide almost complete disposal (more than 99% of the organics are gasified) while also producing substantial clean energy**
- **CHG can completely replace other methods, or can be used to further process sludge from anaerobic digesters**

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# Advantages in Wastewater Treatment

- **Almost completely eliminates wastewater solids—gasifies >99% of organics, leaving only inorganics (typically around 13% of wastewater solids)**
- **Can simplify the wastewater treatment process and reduce the footprint of facilities**
- **Can use in several ways**
  - If do not already have digesters, eliminates need for digesters and gives much higher yields of gas
  - If already have digesters, can gasify remnant sludge and gradually replace digesters over time

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# Animal Waste

- **Animal waste (manure) can be gasified in a similar way to wastewater solids**
- **Waste from dairy, feedlot, piggery and other animal activity can be gasified**
- **Most animal waste is already mixed with significant water as a result of washdown methods in barns and sheds**

# Food Processing Wastes

- **Food processing wastes (fruits, vegetables, potatoes, cooking wastes) can be gasified**
- **These materials often present a significant disposal problem**
  - Some materials cannot be put into a sanitary sewer system
  - Other materials may incur high disposal costs or cause environmental problems
- **CHG can gasify these materials either at the point of production or at a collection center**

# Biofuel or Distillery "Bottoms"

- **"Bottoms" are the biomass materials left after extraction of energy fractions, distillery, or wine products**
- **Examples include remainder material after extraction of desired fractions from grains, grapes, or algae**
  - Corn ethanol bottoms are the portion of corn remaining after extraction of sugar and starch for fermentation into fuel ethanol
  - Distillery bottoms are the portion of various grains remaining after extraction of materials for alcoholic beverage production
  - Winery bottoms are the residue left after extraction of wine-making content (grape juice)
  - Algae bottoms are the biomass material left after extraction of lipids for biodiesel

# Biofuel or Distillery "Bottoms" (cont.)

- **Regardless of source, this material can be easily and completely gasified**
  - Gasification can produce either gas, electricity, or both
  - Gas supplies process heat for distillation, condensation, and drying
- **Alternate use for bottoms is to dry the material and use as a supplement for animal or fish feed**
- **In many cases, gasification will produce economic or process advantages**

# Biomass from Water Remediation

- **Various water plants are used in the remediation of water**
  - Plant growth can remove excess nutrients from the water, as well as other contaminants
- **Water remediation may also involve removal of excess growths such as algae blooms**
- **In either case, the removal of the plant material produces large amounts of biomass which can be gasified via CHG**

# *Cladophora glomerata:*
# High-growth algae, often a nuisance

# *Ulva* (marine genus) in Large Quantities

# *Water Hyacinths* —A Major Nuisance