TETRA TECH

complex world | CLEAR SOLUTIONS™

How to Make Biomass-to-Energy Work in Rural Alaska

Jeff Coombe
Keith Henn
Al Randall

April 29, 2014

www.tetratech.com

Tetra Tech Alaskan Project Experience

3 Office Locations – Anchorage, Fairbanks, Juneau
HelioTech JV – Alaska Native Corporation 8(a)

Tetra Tech Works With Tribal Groups

Cherokee Nation	Northern Arapaho
Cheyenne River Sioux	Northern Cheyenne Tribe
Cheyenne-Arapaho Tribes of Oklahoma	Oglala Sioux Tribe
Chippewa Cree Tribe of the Rocky Boys Reservation	Omaha Tribe of Nebraska
Crow Creek Sioux Tribal Council	Osage Nation
Flandreau Santee Sioux Tribe	Ottawa Tribe of Oklahoma
Fort Peck Tribes	Ponca Tribe of Nebraska
Ho-Chunk Nation	Prairie Band Potawatomi Nation
Iowa Tribe of Kansas & Nebraska	Prairie Island Indian Community
Keweenaw Bay Indian Community	Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
Kickapoo Tribe of Kansas	Red Lake Band of Chippewa Indians of Minnesota
Kickapoo Tribe of Oklahoma	Sac & Fox Tribe of the Mississippi in Iowa
Lac Courte Oreilles Band of Lake Superior Chippewa Indians	Santee Sioux Nation
Lac du Flambeau Band of Lake Superior Chippewa Indians	Shakopee Mdewakanton Sioux Community of Minnesota
Lac Vieux Desert Band of Lake Superior and Chippewa Indians	Shawnee Tribe
Leech Lake Band of Ojibwe	Spirit Lake Nation
Lower Brule Sioux Tribe	Standing Rock Sioux Tribal Council
Lower Sioux Indian Community of Minnesota	Turtle Mountain Band of Chippewa
Menominee Indian Tribe of Wisconsin	Three Affiliated Tribes
Miami Tribe of Oklahoma	Upper Sioux Community of Minnesota White Earth Tribal Council
Mille Lacs Band of Ojibwe Indians	Ysleta del Sur Pueblo

Selecting the Correct Boiler

Project Pillar	Key Project Attribute
Feedstock Supply	▪ Source and Impacts ▪ BTU content vs moisture content ▪ Consistency vs. variety of materials ▪ Toxics / carcinogens
Optimal Plant Sizing	• Energy Off Takes • Electrical Loading • Thermal Loading • Mass & Energy Balance • Site and Project Footprint

Feedstock - Categories

- Waste Biomass
  - Municipal Solid Waste (MSW)
  - Organics – Food waste
  - Fiber – Paper, Cardboard, Wood (RDF)
  - Construction & Demolition (C&D)

- Woody Biomass
  - Chip wood (pulp-and-paper industry standard chip spec)
  - Stewardship & stand thinning
  - Logging slash
  - Mill residues (sawdust & other waste)
  - Fuel wood

Feedstock – MSW

- Unsorted MSW
  - Widely available
  - Difficult to handle / process
- Separation Steps Needed !
  - Higher quality of Feedstock - consistent, homogenous
  - Difficult to implement / reduced capture volume
- Construction & Demolition Waste and Urban Wood
  - Wood, paper, cardboard focus
  - Potential for EPA ‘Biomass’ Designation

Material Recovery Facility (MRF)

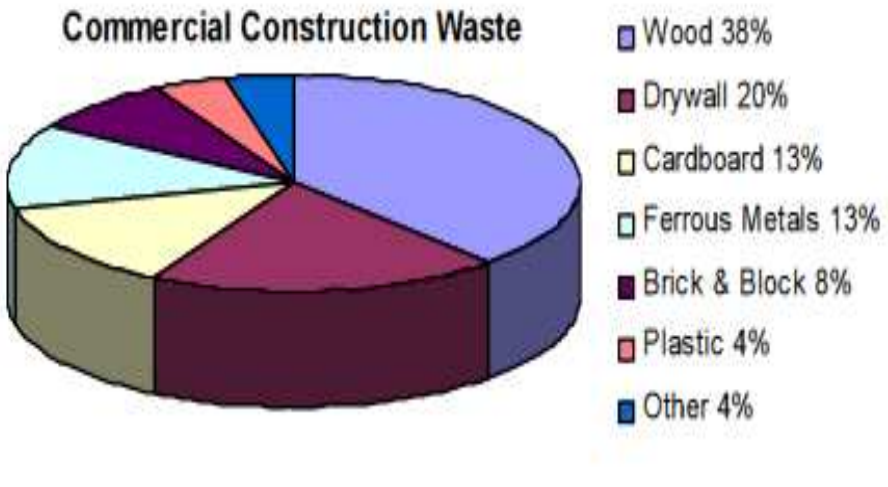
- MSW MRF
  - 20,000 tons/yr min throughput
  - Metals recycling primary

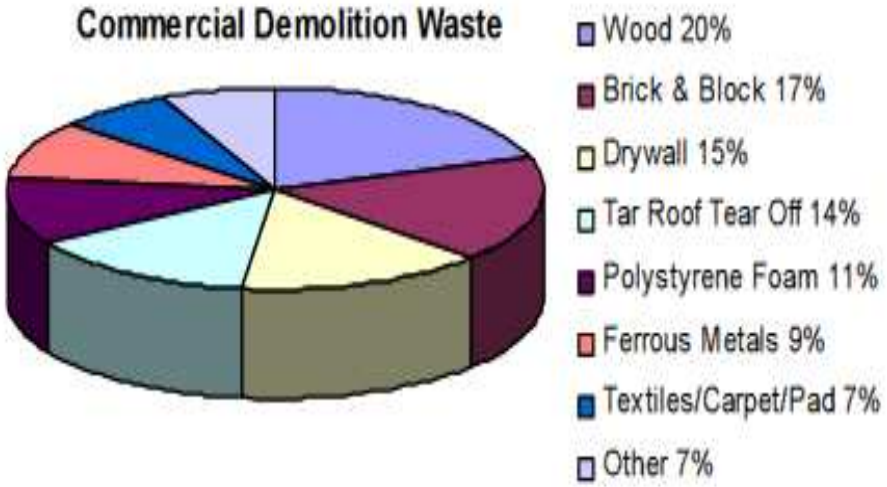
- C&D MRF
  - Aggregate recycling
  - Shingles to hot mix

= Value-added Recycling

Feedstock - Construction & Demolition

- 30-50% woody material
- Negative-cost feedstock
- Value-added byproducts
  - Metals, aggregate, shingles





Source: Illinois Sustainable Technology Center

Feedstock – Woody Biomass

Product
Logging Residue
Mill Residue
Thinning / Stewardship
Chip wood

- Logging Residues - Slash Mitigation
- Forest Hazard Mitigation
- Secondary Growth Market
- Beetle Kill

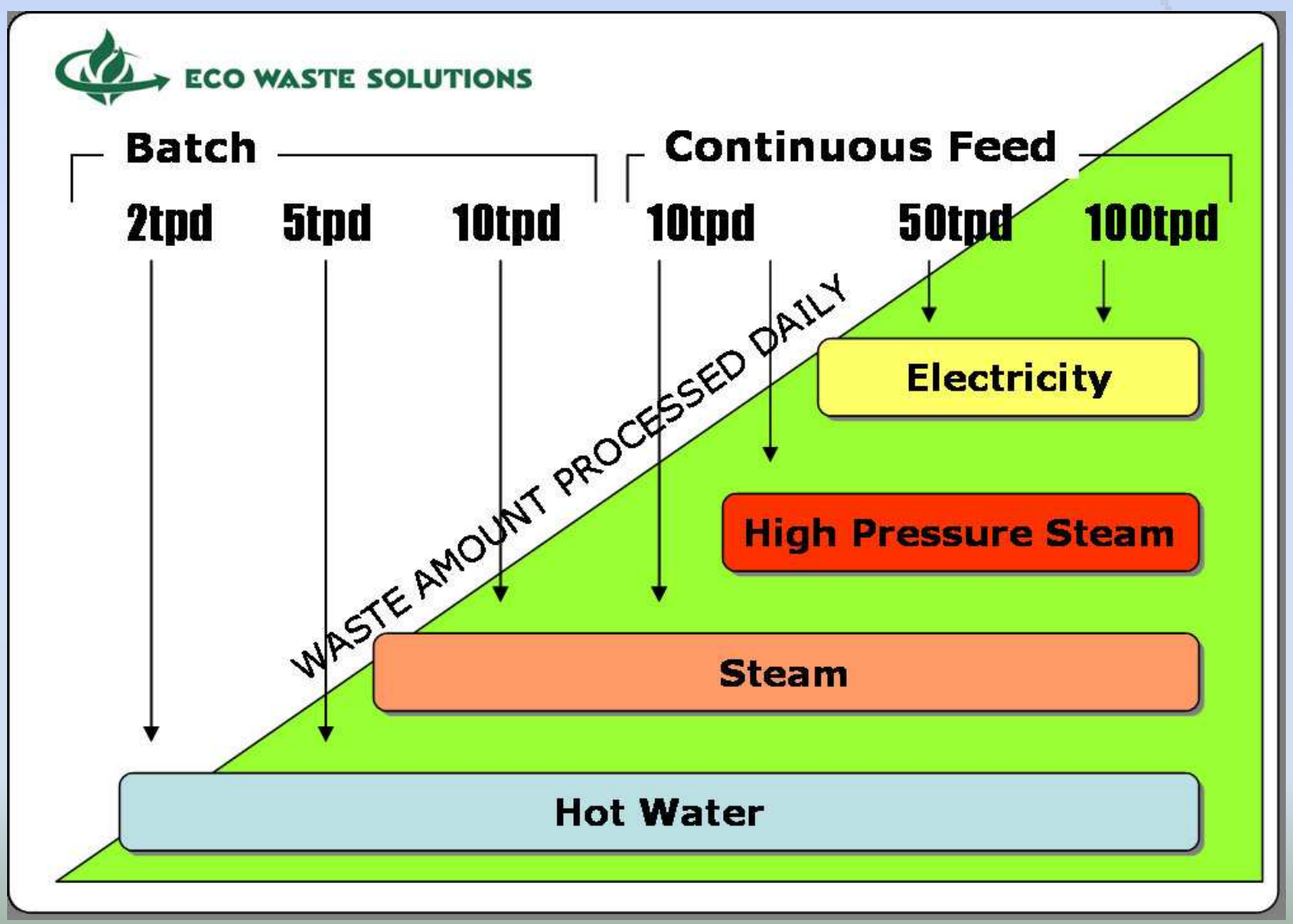
Biomass to Energy Technology

- Technology spectrum

Basic Combustion (Simple)	Hybrid Gasification	Gasification (Complex)

- Products Produced
  - Thermal Heat
  - Combined Heat and Power (CHP)
    - Electricity for Operations (<1 to 10+ MW)
    - Heating / Hot Water / Cooling
  - Syngas / Pyrolysis Oils / Liquid Fuels

Thermal or Electrical Energy



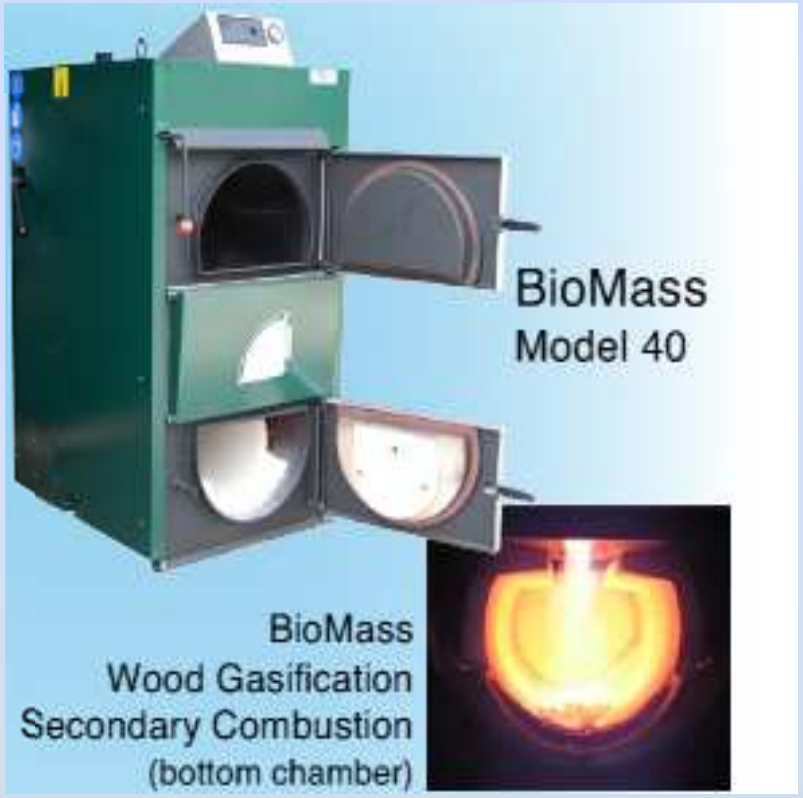
Residential Wood Gasification Boilers

Courtesy: Tarm

Multi-Fuel Boilers (Wood / Oil / Coal)

Courtesy: Alternate Heating (E100 WoodGun)

Courtesy: ATMOS (DC 18 SPL, DC 25 SPL, DC 32 SPL)



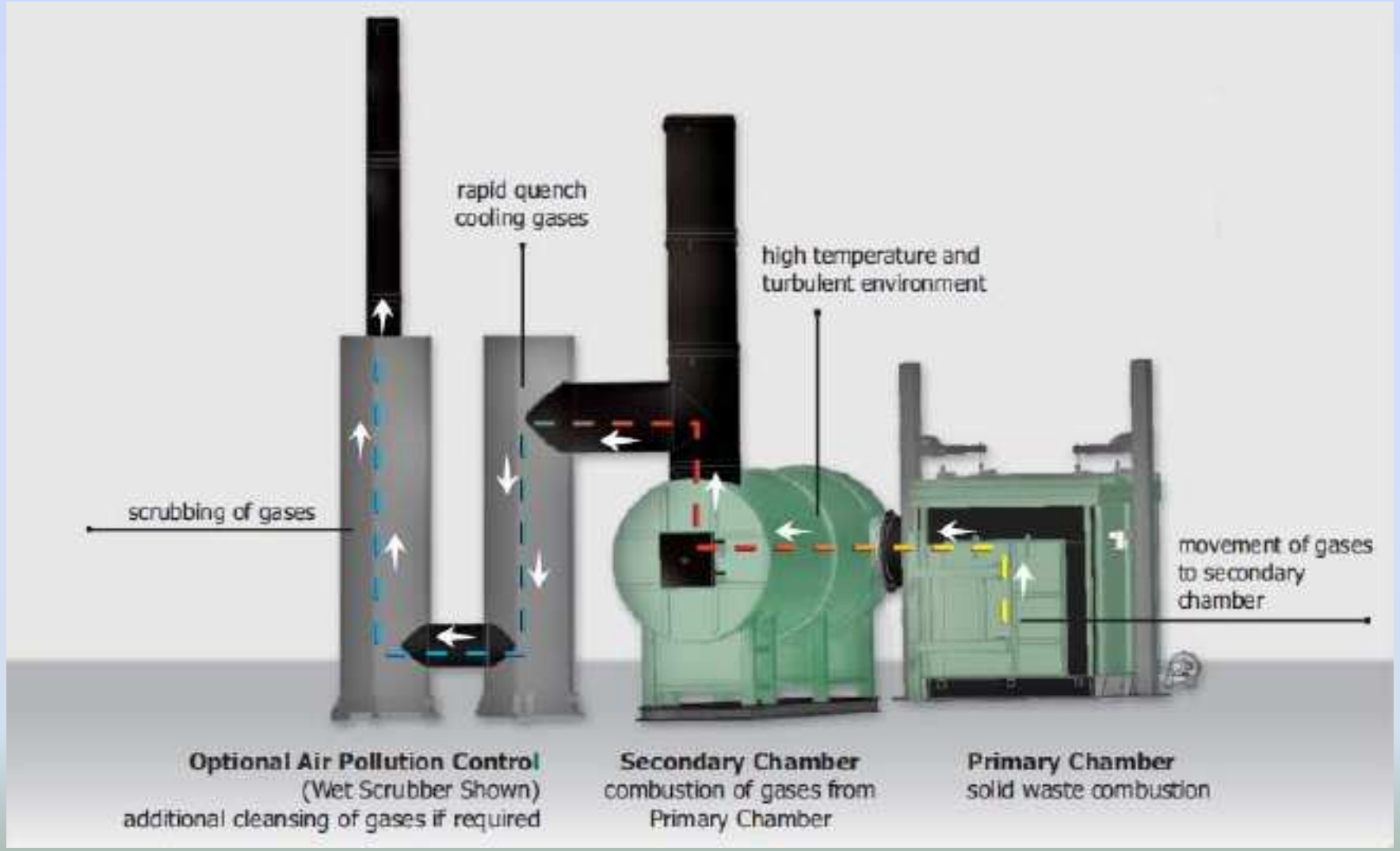
Courtesy: Biomass NExtGen

Community-Scale Gasifiers

GARN WHS-1000 • PERFORMANCE and SPECIFICATIONS

Maximum Heat Output *(with 20% MC Oak)*	180,000 (BTU/H)
Tested Efficiency (LHV) *(using 20% MC Oak)*	80.0%
Gallons of Storage	980 Gallons
BTUs Stored *(based on 65° F temperature rise)*	540,000 BTUs
Weight [Empty] • [Full]	2,200 lbs • 8,150 lbs
Recommended Wood Dimensions	16" - 20" long • 3"-10" diameter
Combustion Chamber Dimensions	36" long • 24" diameter
Pipe Connections	1.5" NPT Supply • 1" NPT Return
Induced Draft Fan	1/2 Horsepower (115vac, 15amp)
Flue	6" Duratech Class A
Off-peak Electric Backup (Optional)	Up to 33kw [5.5KW elements]
Solar Storage Connections	Optional

Hybrid Gasification



Courtesy: Eco Waste Solutions

Hybrid Gasification

Pro's

- Accepts plastic and contaminants
- Higher efficiency over combustion

Con's

- Higher CapEx $10MM +
- Minimum size ~ 2MW CHP
- More complex

Courtesy: Envikraft

The photos below depict 4,000 lbs of unsorted MSW before and after processing:

Courtesy: Eco Waste Solutions

Drivers for Bioenergy & Waste to Energy

Energy, Savings & Jobs

- Electricity in remote locations >> $$$ (Kotzebue – 42 ¢ / kWh)
- Diesel Prices - $6 to $10 / gallon
- Landfills >> High operation costs & tipping fees
- SE AK – secondary growth markets

Secure Power and Landfill/Waste Diversion

- Local, Base load Power
- Recycling, Landfill diversion, value-added byproducts
- Job Creation & “Economic Clusters”
- Funding Sources Available

Take Home Message!

- Bioenergy / WtE are proven technologies
- Bioenergy / WtE uses local waste resources
- Systematic Evaluation process is required

One size does not fit all…

Bioenergy / WtE can work in many rural towns ! !

Thank you!

Jeff Coombe
Jeff.Coombe@tetratech.com