

# Waste to Energy

*BIA Providers Conference*

*Anchorage, Alaska*

*December 1, 2015*

George Roe

Research Professor

University of Alaska - Fairbanks

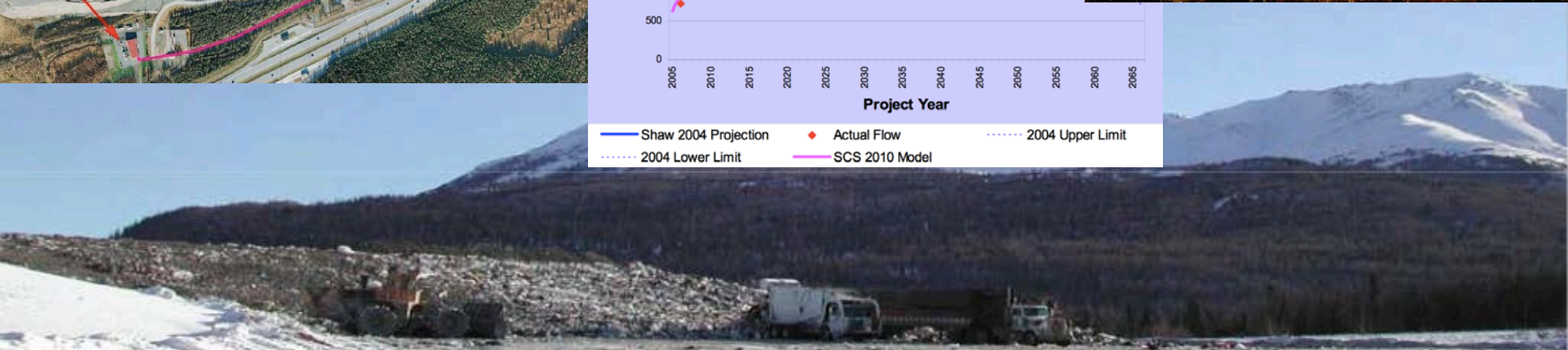
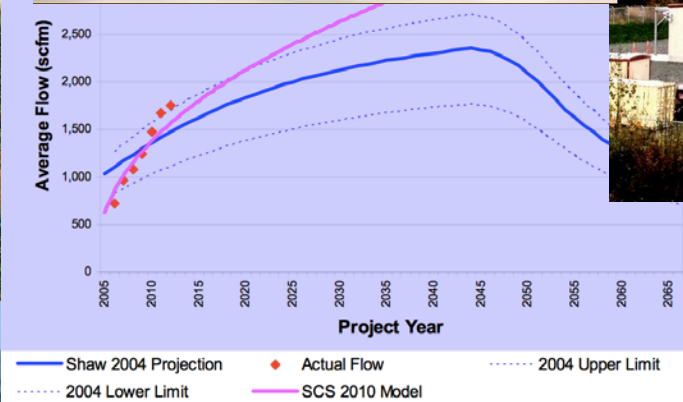
# What is waste-to-energy (W2E)?

- Types of waste ...
- Kinds of energy ...
- Key attributes ...
- Key considerations ...

Back | Forward | Home | Search

# ANC landfill gas-to-energy project

- 5.6 MWe
- ARL to JBER
- Online Aug 2012
- Run by Doyon Utilities



# Alaska Department of Environmental Conservation

## Solid Waste Program



Lori Aldrich  
Regional Program Manager

# Rural landfills



# Rural sewage lagoons



Small Septage Lagoon



Large Honeybucket Lagoon



Large Lined Lagoon

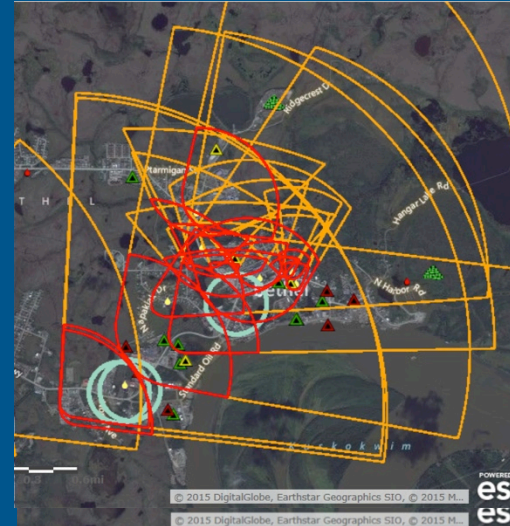


Honeybuckets at Landfill

# Gathering information

## ADEC

- Solid Waste Program
- SWIMS database
- Village Safe Water
- GIS Map




## EPA

- STARS (Sanitation Tracking and Reporting System)

**Sanitation Tracking and Reporting System (STARS)**  
Welcome to STARS, a system of the Indian Health Service (IHS).

**SELECT AN AREA**  
Click an area on the map or the list below:



- ▶ Aberdeen Area
- ▶ Alaska Area
- ▶ Albuquerque Area
- ▶ Bemidji Area
- ▶ Billings Area
- ▶ California Area
- ▶ Nashville Area
- ▶ Navajo Area
- ▶ Oklahoma Area
- ▶ Phoenix Area
- ▶ Portland Area
- ▶ Tucson Area

The mission of the Indian Health Service (IHS) is to raise the health status of the American Indian and Alaska Native people to the highest possible level by providing comprehensive health care and preventive health services. To support this mission, the Division of Sanitation Facilities Construction (DSFC) provides technical assistance and sanitation facilities services to American Indian (AI) and Alaska Native (AN) villages for cooperative development and continued operation of safe water, wastewater, and solid waste systems and related support facilities. STARS is a web-based database used to track sanitation facilities projects. It also contains information on existing Operation and Maintenance (O&M) organizations serving American Indians and Alaska Natives (AI/AN).

STARS includes six major data systems:

1. **CONNECTIVITY**, also known as CDP (Community Deficiency Profile), contains demographic information on the communities where projects and homes are located.
2. **DSFC** - the Sanitation Deficiency System documents information about sanitation deficiencies related to ALL US individual homes and communities.
3. **DSFC** - the Project Data System is used to track DSFC sanitation facilities construction projects.
4. **HPS** - the Housing Priority System is used to document, prioritize, and allocate resource needs for DSFC projects for new and in-use housing.
5. **OMDS** - the Operation and Maintenance Data System contains information about water, wastewater and solid waste systems serving AI/AN people and the organizations that operate systems; and
6. **SR's** - Service Requests are used to track applications for sanitation facilities to individuals and specific home sites (unimproved sites).
7. **HITS** - the Home Inventory Tracking System, is a geospatial inventory of tribal homes used to track the status and plan for the provision of sanitation facilities.

# W2E potential benefits

- Reduce landfilled waste
  - Extend landfill life
  - Reduce landfill management
  - Eliminate sewage solids monofills
- Improved air quality
  - Less emissions than burn box
  - Reduced fire dangers
- Provide energy as power or heat



# W2E potential difficulties

- Expensive
  - Long term investment
  - Requires a building
  - Diesel start up
- Unfamiliar technology
  - Training to operate
  - Difficult to repair
- May require additional permits

# W2E permitting

- Solid Waste
  - Treatment Permit if over 5 tons /day
  - Plan approval if less
  - Ash sampling
- Air Quality
  - Required for incinerator over 1000#/hour capacity
  - Minor Permit
  - Emissions Monitoring

# Systems currently in use

- Used Oil Burners

- Common in rural communities
- Difficult to manage waste



- Biomass Burners

- Burning pellets or logs from wood, plants, or paper





So, what about energy from waste?

# Future?



# Interests & priorities

- Extend usability of existing landfills
- Reduce health risks associated with polluted ground & surface waters
- Intercept / mitigate contaminants threatening drinking water & natural habitat
- Replicable / scalable in AK context
- Affordable & reliable

When is net energy neutral good enough?

# “Triple bottom line” perspective

## Economic

- Health care & tipping fees cost reduction
- Possibility to sell ash or use for construction projects in town
- Offsets heating or electric cost

## Environmental

- Reduces toxic chemicals entry to water / food
- Reduces unwanted human/wildlife contact
- Reduces greenhouse gas emissions

## Social

- Reduce human contact and exposure to waste
- Health benefits to increased air quality
- Improved aesthetics

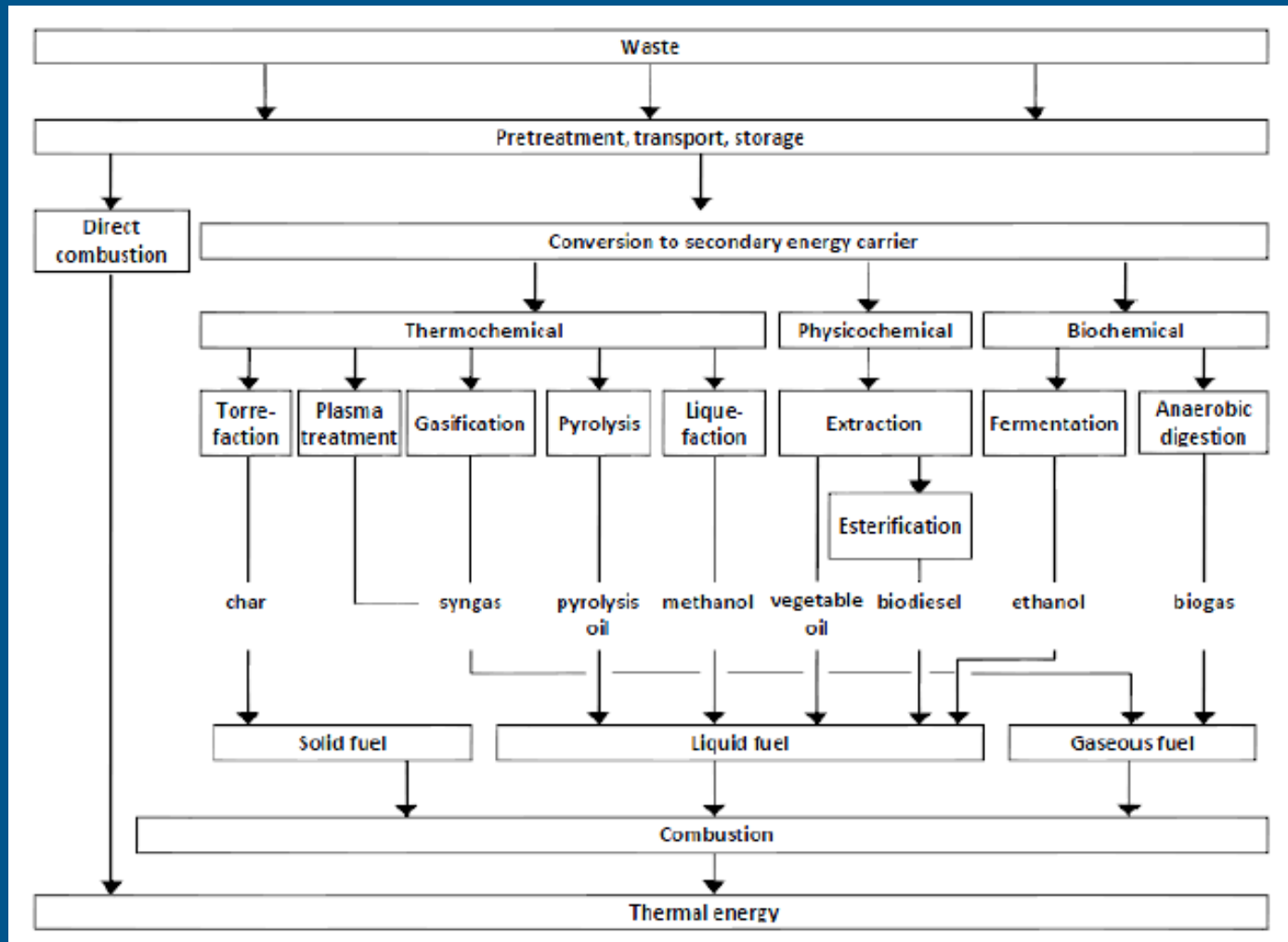
# Thermal energy from ...



Temperature range ~ 120 – 450 deg F



# Waste to energy – the technologies

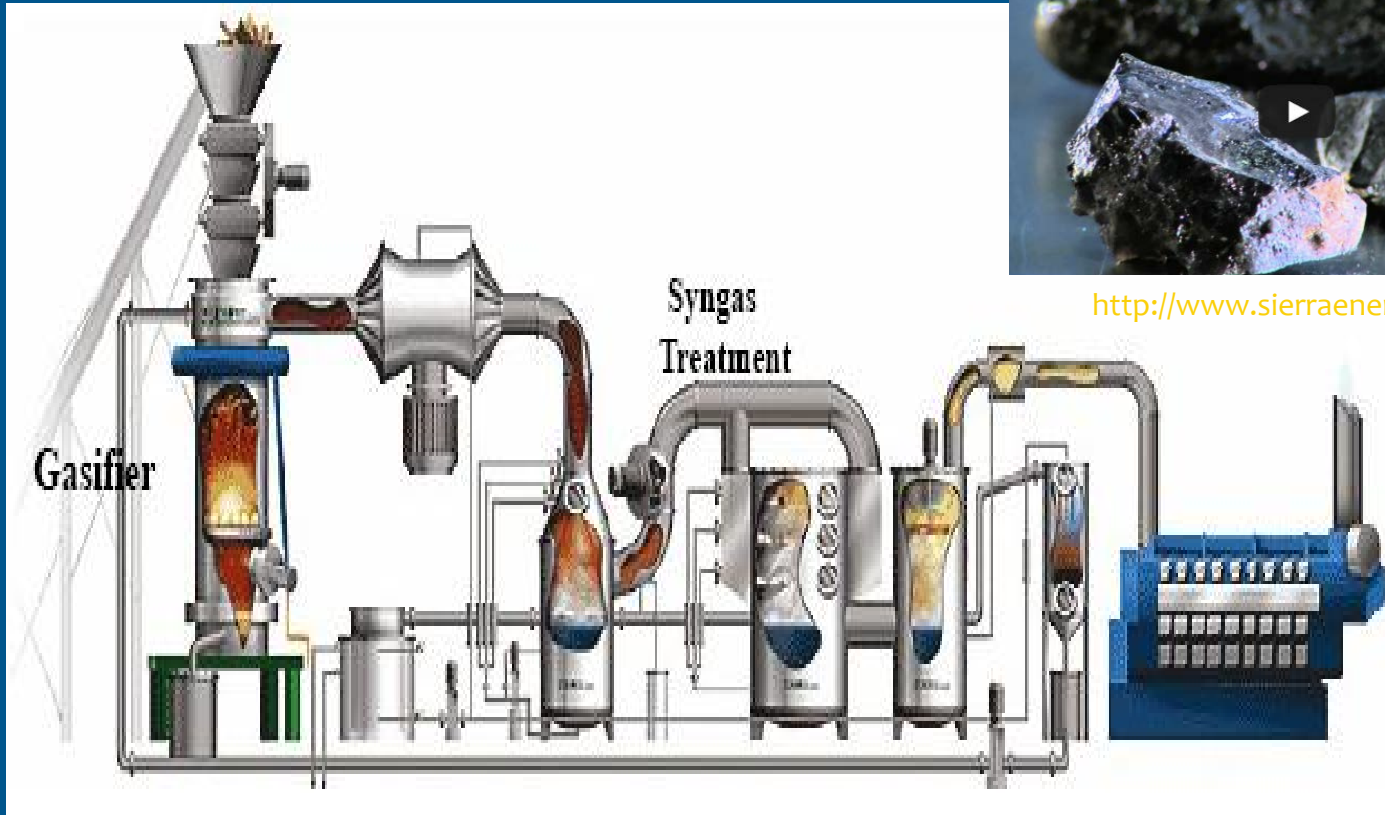


Source: Bosmans, A. and L. Helsen. 2010

# Waste to energy – anaerobic digestion



# Waste to energy – gasification



<http://www.sierraenergycorp.com/>

# Waste to energy – plastics to fuel



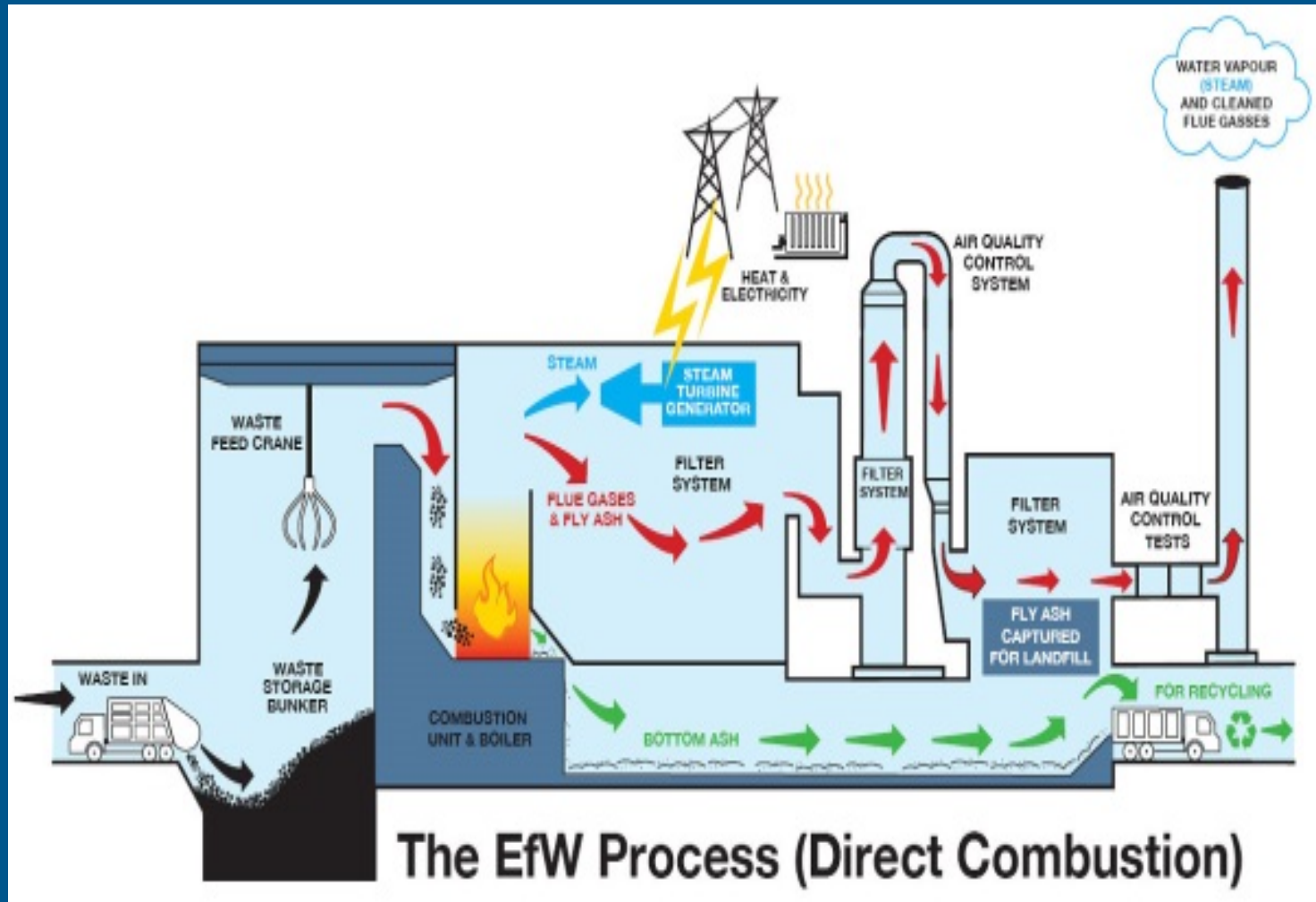
United Nations University's Our World Magazine  
<http://ourworld.unu.edu/en/plastic-to-oil-fantastic>

- Maturity?
- Net energy?
- Operating costs
- Best-value product utilization
- Feedstock capture, type & preparation



<http://www.plastic2oil.com/>

# Waste to energy – incineration



# Cardboard as a heating fuel



- Cardboard - Corrugated shipping boxes
- Processing
  - Removed banding, staples, tape, and labels
  - Cardboard is abrasive -will reduce life of pelletizing dies
- Combustion
  - White boxes usually chlorine-bleached → corrosion / early failure
  - High ash volumes produced → requires more handling
  - 13.8 mmBtu/ton – lower heating value than wood
  - Moving grate boiler allows for better control of combustion.
  - EVO World and Garn interested in testing cardboard as a fuel
  - Air permitting might be required depending on system size

# Some W2E options



<http://janickibioenergy.com>

- Need?
- Technology status?
- Scale?
- Environment?
- Funding?



<http://wtecanada.com>

<http://impactbioenergy.com>

# Considerations for a W2E project

## 1. Waste stream

- Types of MSW?
- % of combustibles?
- Weight of combustibles?
- Separation? Percent recovery?
- Condition – contamination, moisture, ...?

## 2. Heat loads

- Located near waste boiler
- Annual usage of heating fuel



# Dump Site Waste Inventories

Community Comparison Waste Stream Percentages			
Material	Kotzebue	Kalskag	Canada
Food Waste	18.60%	14%	19.60%
Cardboard	18.70%	6.30%	10.90%
Paper	14.10%	20.40%	17.40%
Metal	8.60%	8.70%	10.30%
Plastics/rubber/leather	17.90%	10.00%	12.20%
Glass	4.80%	2.50%	4.10%
Wood	6.50%	-	11.30%
Textiles	2.80%	-	3.70%
Diapers	-	12.40%	6.70%
Bathroom/medical waste	-	12.60%	-
Other Trash	8.00%	13.00%	3.80%
Total	100.00%	100%	100.00%

Community Comparison Waste Total			
Material	Kotzebue(tons/yr)	Kalskag(tons/6 months)	Northwest Territories(tons/yr)
Food Waste	90.00	7.20	93.90
Cardboard	290.00	3.20	52.20
Paper	220.00	10.40	83.40
Metal	140.00	4.40	49.30
Plastics/rubber/leather	270.00	5.10	58.40
Glass	80.00	1.30	19.60
Wood	60.00	-	54.10
Textiles	40.00	-	17.70
Diapers	-	6.30	6.30
Bathroom/medical waste	-	6.40	-
Other Trash	130.00	6.60	18.20
Total	1,320.00	50.90	453.10

X – Y tons / person / year

X – Y % wood, paper and cardboard

# US Army waste stream – contingency bases

Waste Component	CB #1	CB #2	CB #3	CB #4	CB #5	Afghanistan Avg (Weighted) <sup>b</sup>	
Corrugated Cardboard	9.5%	15.10%	9.3%	13.1%	16.2%	13.7%	
Food Waste	15.5%	20.70%	24.5%	15.5%	24.6%	19.1%	
Liquid	NR <sup>b</sup>	5.80%	7.4%	7.3%	6.4%	6.6%	
Miscellaneous Waste	5.1%	1.10%	3.6%	1.5%	2.0%	1.6%	
Mixed Paper	28.8%	13.30%	10.5%	14.4%	5.3%	13.2%	
Non-Combustible	Ferrous Metal	1.2%	3.30%	5.7%	2.4%	3.5%	3.2%
	Non-Ferrous Metal	2.3%	1.80%	2.0%	1.4%	1.1%	1.6%
	Glass	1.0%	0.20%	0.2%	0.2%	0.7%	0.2%
Other Combustible	5.5%	0.50%	2.2%	2.2%	0.8%	0.5%	
Plastics	#1 - PET	10.6%	7.00%	5.5%	6.1%	3.2%	6.4%
	#2 - HDPE	5.0%	5.40%	4.2%	1.6%	1.6%	3.7%
	#3 - PVC	4.4%	0.70%	0.8%	0.5%	1.2%	0.7%
	#4 - LDPE/LLDPE	1.3%	2.80%	1.9%	3.1%	1.0%	2.8%
	#5 - PP	0.1%	0.20%	0.3%	0.2%	0.1%	0.2%
	#6 - PS	7.3%	2.20%	1.0%	1.2%	1.0%	1.6%
	#7 - other	0.1%	0.70%	0.4%	0.6%	0.5%	0.6%
Total Plastic (All Types)	28.8%	19.00%	14.1%	13.3%	8.6%	16.0%	
Textile	1.3%	5.40%	4.1%	5.6%	3.0%	5.3%	
Wood	1.0%	13.70%	16.5%	25.3%	27.0%	18.9%	
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

<sup>a</sup>Due to rounding, some percentages different from some other tables and figures and some totals do not add up to 100%. Percentages generally rounded to nearest tenth of a percent.

<sup>b</sup>Averages for Afghanistan bases weighted in proportion to the base total weight of waste processed annually. Refer to appendix C for more information (page C.9).

Source: U.S. Army Logistics Innovation Agency. 2013

# Waste stream trends

Biogenic	Non-Biogenic
Newsprint	Plastics
Paper	PET
Containers & packaging	HDPE
Textiles	PVC
Yard trimmings	LDPE/LLDPE
Food wastes	PP
Wood	PS
Other biogenic	Other plastics
Leather	Rubber
	Other non-biogenic

- Organic biogenic content decreasing
- Paper biogenic content increasing
- Non-biogenic content increasing
- Pharmaceuticals & other contaminants

# Waste energy & moisture content

Source: U.S. Army Logistics Innovation Agency. 2013

Category	Heat Content (MMBtu/dry ton)	
Corrugated Cardboard	17	
Food Waste	13	
Liquid	0	
Miscellaneous Waste	20	
Mixed Paper	7	
Non-Combustible	Ferrous Metal	0
	Non-Ferrous Metal	0
	Glass	0
Other Combustible	27	
Plastic	#1 - PET	21
	#2 - HDPE	19
	#3 - PVC	17
	#4 - LDPE/LLDPE	24
	#5 - PP	38
	#6 - PS	36
	#7 - other	21
Textile	14	
Wood	10	

Waste Component	Average Field Measurement	
Corrugated Cardboard	12.6	
Food Waste	53.6	
Liquid	100.0	
Miscellaneous Waste	57.8	
Mixed Paper	34.1	
Non-Combustible	Ferrous Metal	0.0
	Non-Ferrous Metal	1.3
	Glass	0.0
	Other Combustible	6.4
Plastic	#1 - PET	0.0
	#2 - HDPE	9.6
	#3 - PVC	6.7
	#4 - LDPE/LLDPE	14.4
	#5 - PP	0.0
	#6 - PS	7.2
	#7 - Other	1.6
Textile	21.9	
Wood	7.9	

Moisture %

1.98 MMBtu/ton water to heat from 68 to 212- deg F & evaporate

# MSW waste resource

## MSW Generation (tons/person/year)

- Village: 0.19
- Hub Town: 0.41
- US Average: 0.81

		MSW Generation (Ton/day)		
Location	Population	Village	Hub Town	US Avg
Alaska	736,000	383	827	1,633
ANC-FAI-JNU	530,000	276	595	1,176
Other	206,000	107	231	457
Hub Town	4,500	2.3	5.1	10.0
Village	75	0.0	0.1	0.2

# Does it compute?

## Waste generation scenario

Rate	54,000 tons/year
Energy content	10.0 MMBtu/ton
Moisture content	20% %
Conversion efficiency	80% %
Annual energy	328,493 MMBtu/year

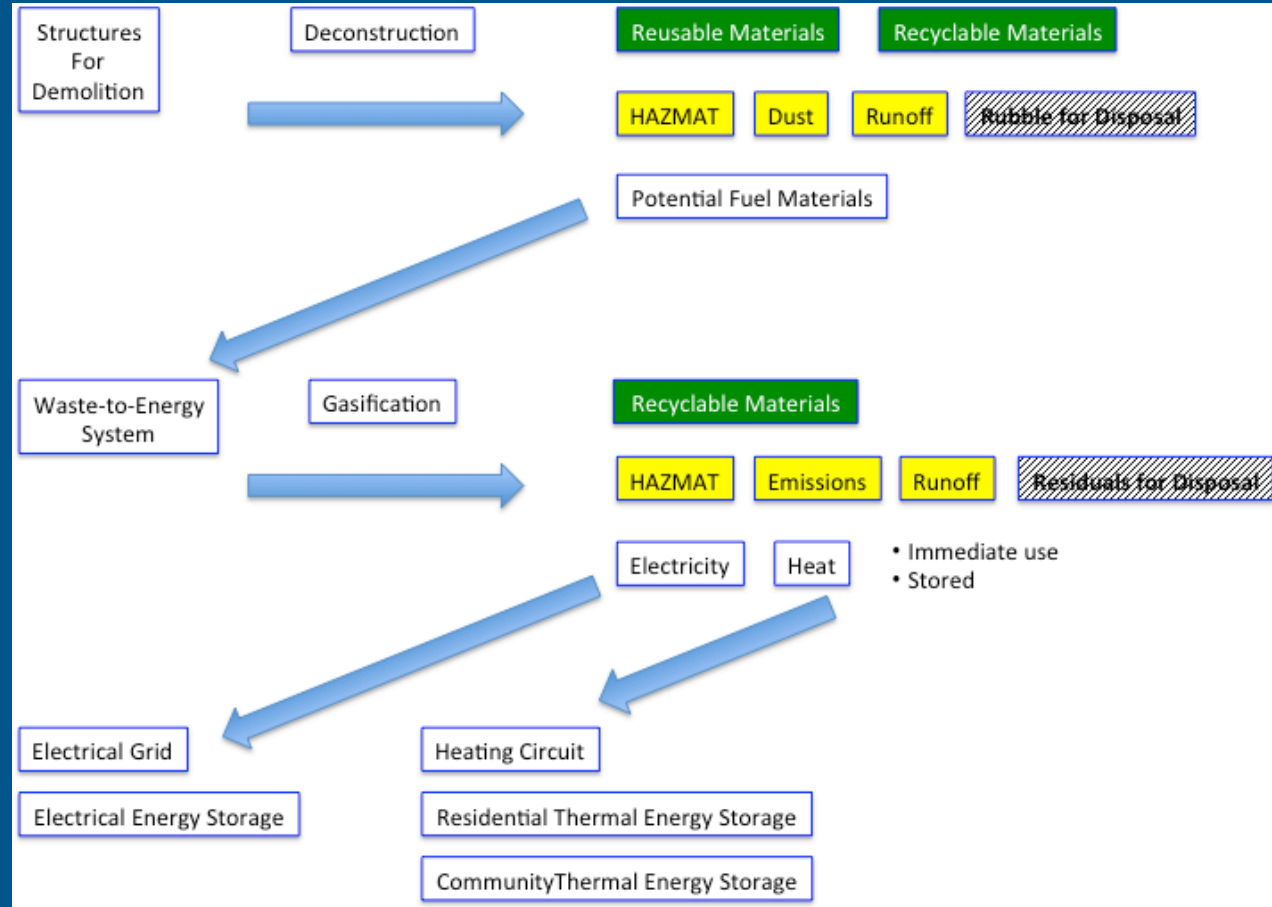
## ... vs. Building Energy Requirements (MMBtu/year)

	Residential	Non-residential
Climate zone 6	202	2,546
Climate zone 7	282	2,474
Climate zone 8	264	4,572
State average	269	3,152

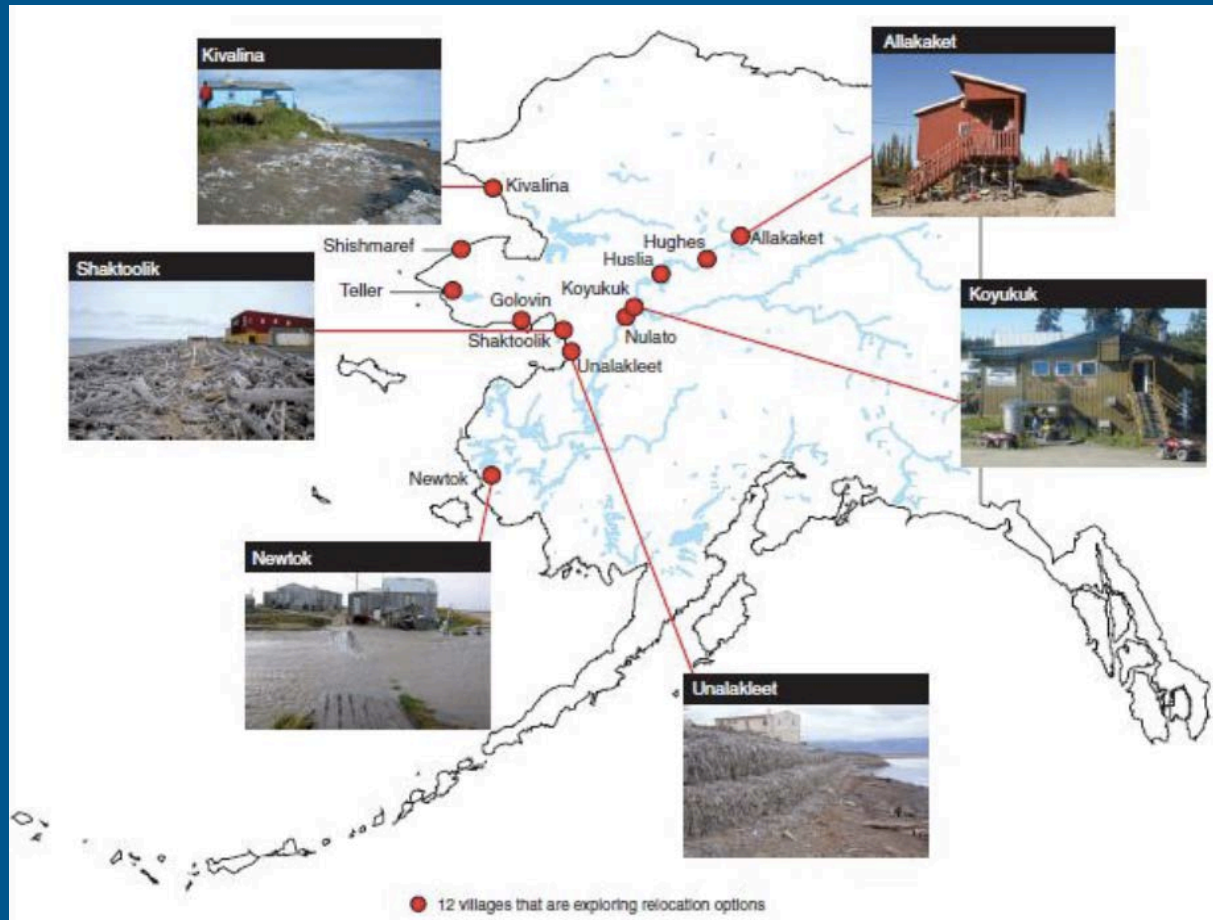


	Zone 6	Zone 7	Zone 8	Zone 9
<b>Alaska Census Areas</b>	Juneau Ketchikan Gateway Prince of Wales Sitka Skagway-Hoonah-Angoon Wrangell-Petersburg Yakutat Haines	Aleutians East Aleutians West Anchorage Bristol Bay Dillingham Kenai Peninsula Kodiak Island Lake and Peninsula Matanuska-Susitna Valdez-Cordova	Bethel Denali Fairbanks North Star Nome Northwest Arctic Southeast Fairbanks Wade Hampton Yukon-Koyukuk	North Slope
<b>HDD (65) per IECC 2012</b>	7,200 - 9,000	9,000 - 12,600	12,600 - 16,800	16,800 - 21,000

# From Rubble to Rubles?



# Climate change → village relocation





# Leverage opportunity?

- Defense & industry investing in transportable waste-to-energy technology
- Multiple feedstock options
  - Agriculture & food industry waste
  - Seafood processor waste
  - Municipal solid waste
  - Sewage lagoons
  - Building demolition
  - ...



Joint Deployable Waste to Energy Program

# W2E collaboration opportunities

- Needs assessment
- Resource evaluation
- Technology guidance
- Prototype testing
- Field demonstrations
- Replication & scaling
- Best practices
- Commercialization
- Support



Local → Regional → National → Global

# A working group?

- Identify interested organizations
- Identify waste-related challenges experienced by communities
- Review available waste inventories
- Assess feedstock opportunities
- Match feedstock with system supplier capabilities
- Develop replicable / scalable demonstration / pilot program with evaluation criteria
- Collaborate with DoD on JDW2E evaluation
- Leverage in-state and external funding resources

# Points of contact

## Lori Aldrich

Regional Program Manager  
ADEC Solid Waste Program  
(907) 269-7622  
lori.aldrich@alaska.gov

## Eric Hanssen

Senior Energy Project Manager  
Alaska Native Tribal Health Consortium  
(907) 729-3620  
echanssen@anthc.org

## Givey Kochanowski

Alaska Program Manager  
U.S. DOE - Office of Indian Energy  
(907) 271-1423  
givey.kochanowski@hq.doe.gov

## Devany Plentovich

Biomass Program Manager  
Alaska Energy Authority  
(907) 771-3068  
dplentovich@aidea.org

## George Roe

Research Professor  
Alaska Center for Energy & Power  
(206-454-9189  
gmroe@alaska.edu