Waste to Energy

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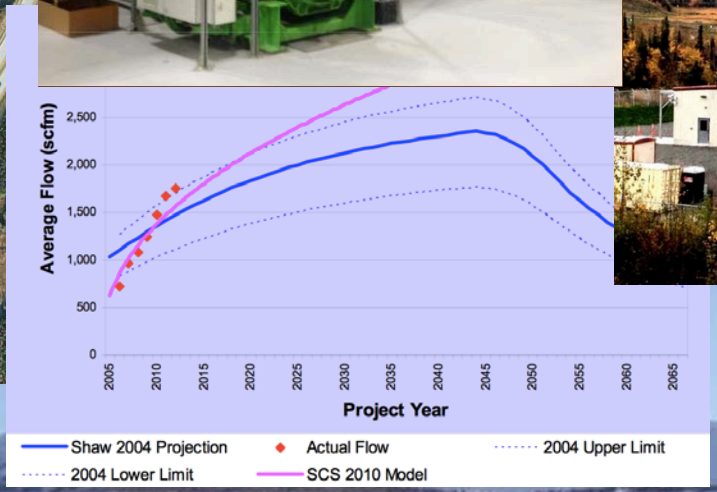
What is waste-to-energy (W2E)?

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

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

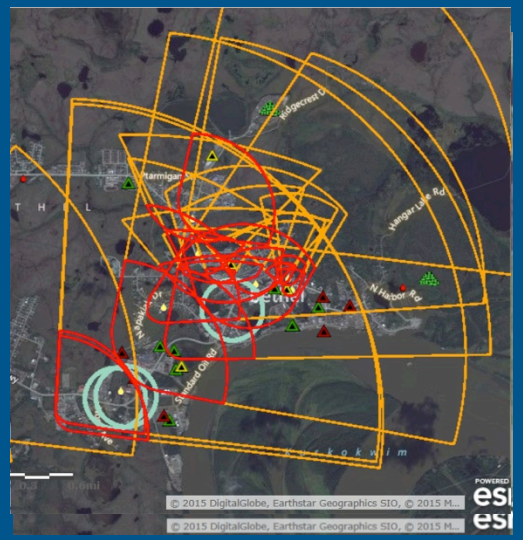

Large Lined Lagoon


Honeybuckets at Landfill

Gathering information

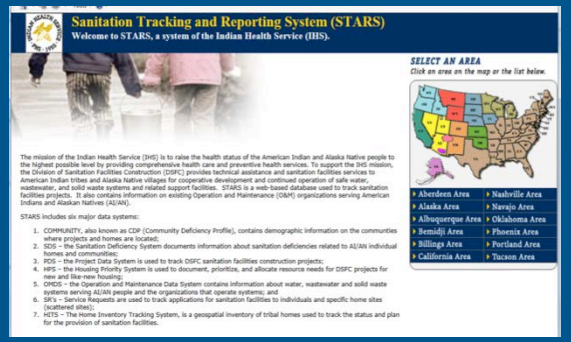
ADEC

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



EPA

- STARS (Sanitation Tracking and Reporting System)



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?

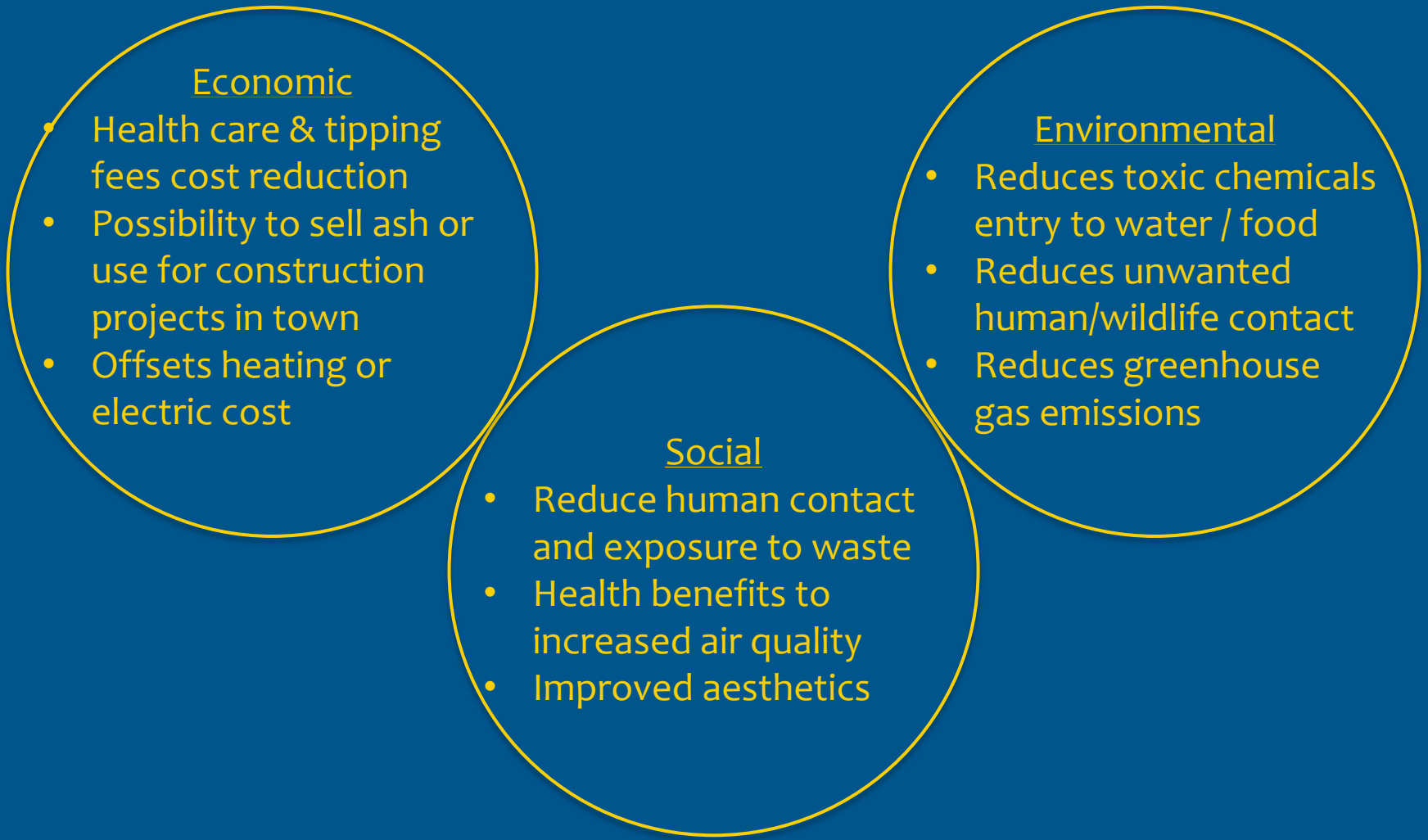
Future?

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?

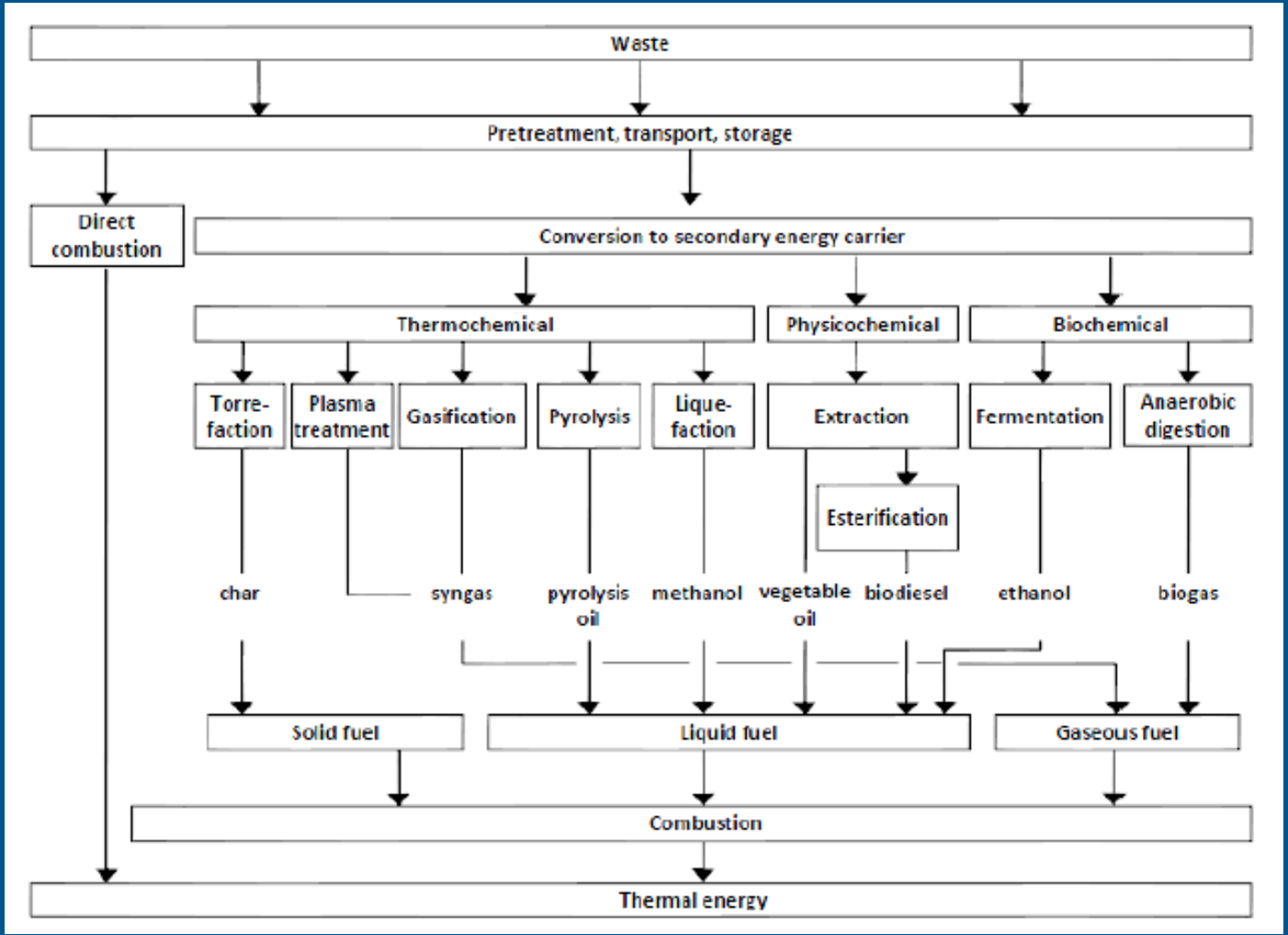
“Triple bottom line” perspective



Thermal energy from …

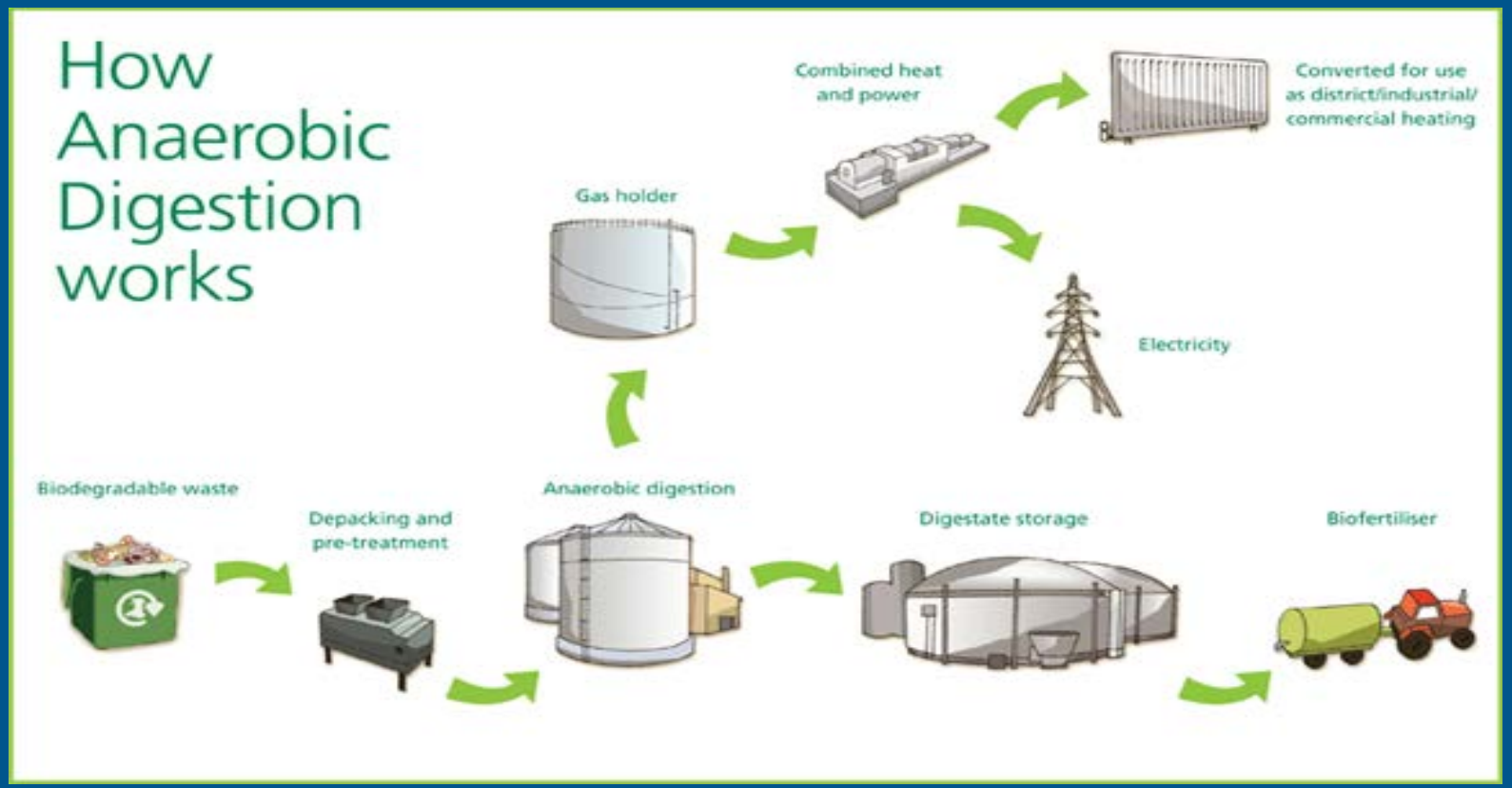
Temperature range ~ 120 – 450 deg F

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/

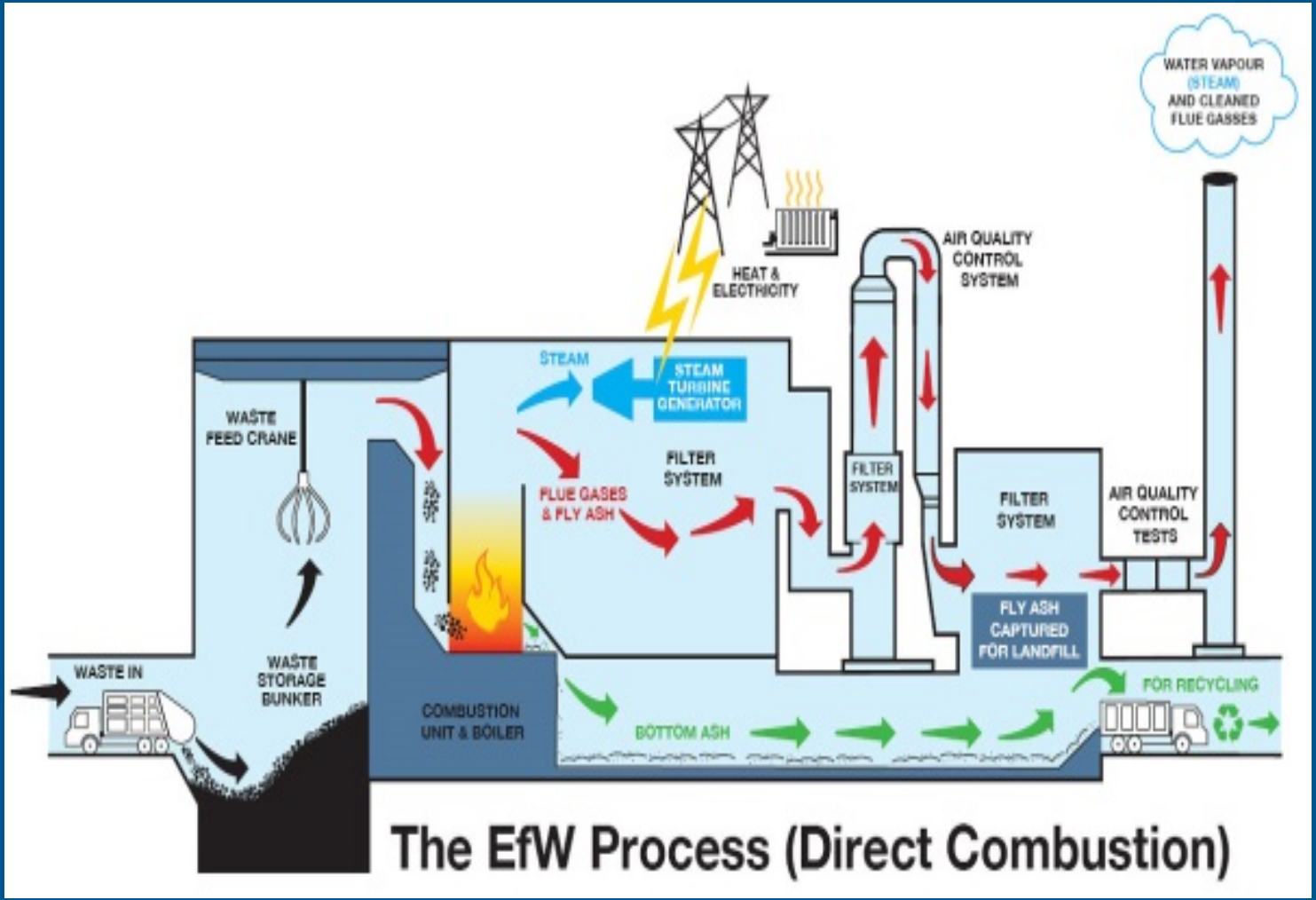
Waste to energy – plastics to fuel

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

http://www.plastic2oil.com/

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

Waste to energy – incineration

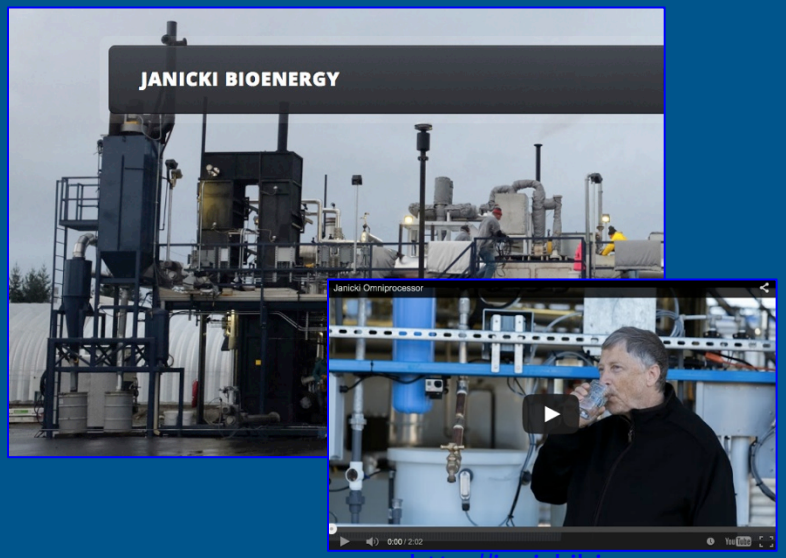


Cardboard as a heating fuel

- 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://wtecanada.com



http://janickibioenergy.com

http://impactbioenergy.com

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

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)[b]
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[b]	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%

[a]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.
[b]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

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

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

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

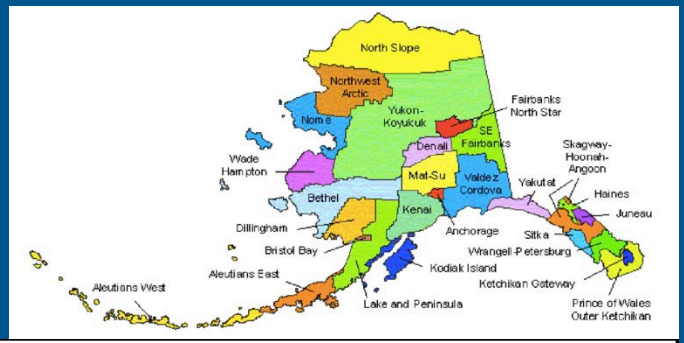
		MSW Generation (Ton/day)		
Location	Population	Village	Hub Town	US Avg
Alaska	736,000	383	827	1,633
ANC-FAI-JNU	530,000	276	595	1,176
Other	206,000	107	231	457
Hub Town	4,500	2.3	5.1	10.0
Village	75	0.0	0.1	0.2

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

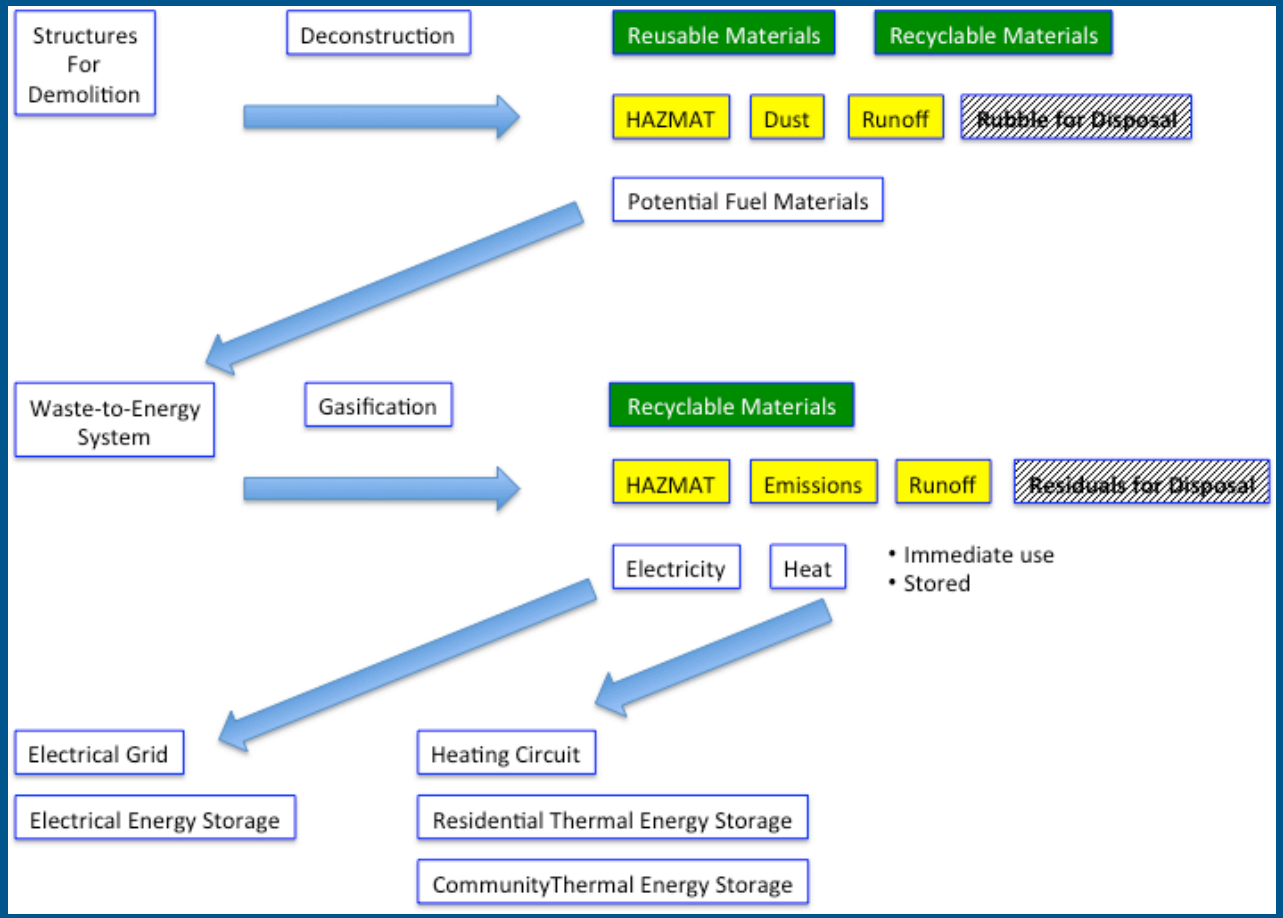
… vs. Building Energy Requirements (MMBtu/year)

	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

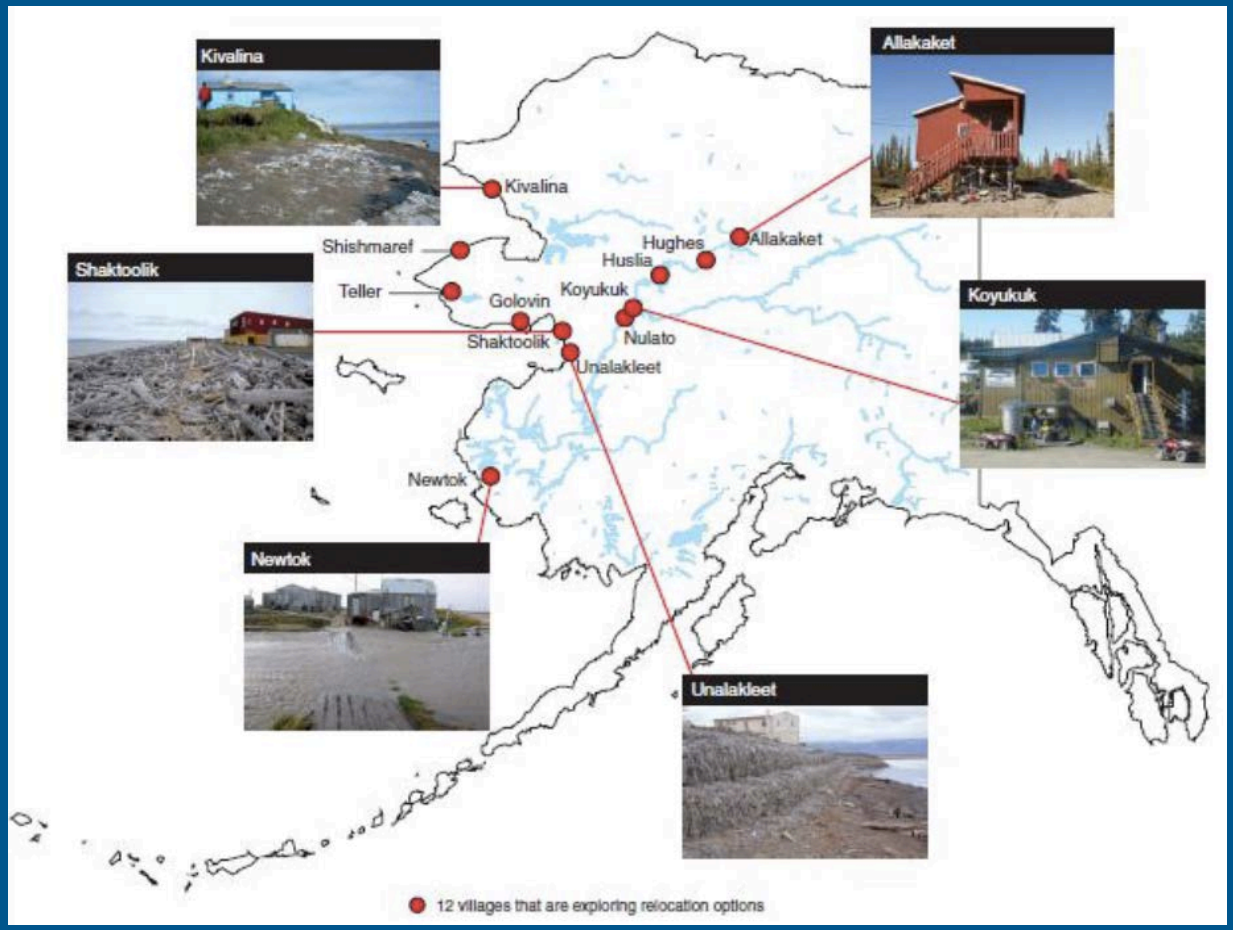


	Zone 6	Zone 7	Zone 8	Zone 9
Alaska Census Areas	Juneau Ketchikan Gateway Prince of Wales Sitka Skagway-Hoonah-Angoon Wrangell-Petersburg Yakutat Haines	Aleutians East Aleutians West Anchorage Bristol Bay Dillingham Kenai Peninsula Kodiak Island Lake and Peninsula Matanuska-Susitna Valdez-Cordova	Bethel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

Sustainable Cruise

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

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