



Waste Conversion Technologies for Minnesota

Presented by:
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Recycling Association of Minnesota / SWANA
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Steve Simmons

- Senior Vice President
- Over 35 years of experience in conversion technologies
- Has developed, designed, built, and operated multiple conversion systems
- Has investigated 40+ waste/biomass plants worldwide





Waste to Energy Experience

- Project Engineer for the American Ref-Fuel team that built the Essex County Facility in Newark, NJ
- Business Manager for the Delaware Valley Facility , Chester PA.



GBB Quality – Value – Ethics – Results



- Established in 1980
- Solid Waste Management and Technology Consultants
- Helping Clients Turn Problems into Opportunities





GBB's Waste Consulting Services

- Economic, technical and environmental reviews
- Procurements
- Due diligence third-party reviews
- Waste characterization and sourcing
- Process planning and conceptual designs
- Independent feasibility consultant



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Suppose

- You represent a community in Minnesota that already recycles / diverts 30+% of its waste stream,
- But your citizens / community leaders want to divert more, maybe 70% or more,
- What are options that are viable over the next 5+ years

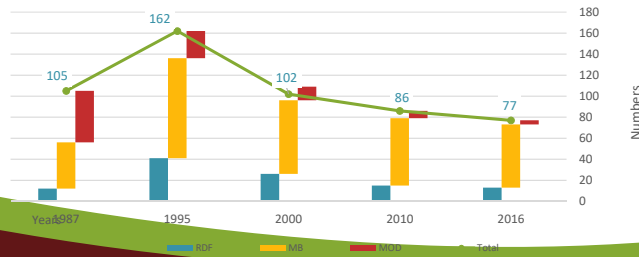


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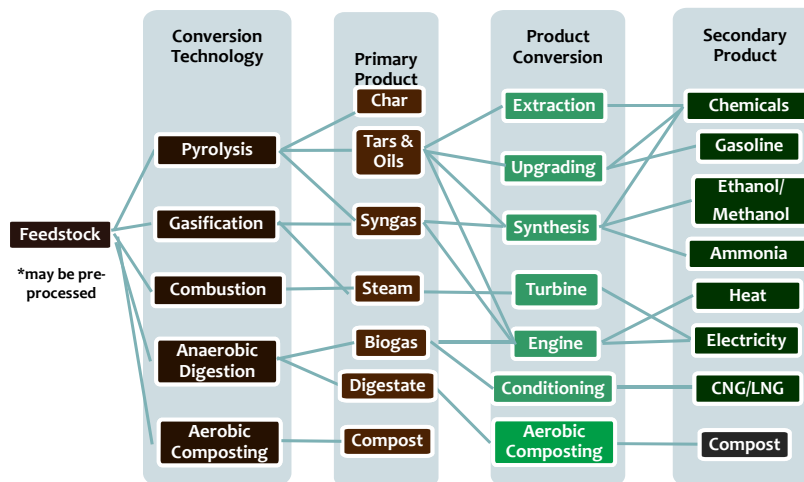


Traditional Mass Burn Combustion is on the Decline

Year	Numbers of Plants			Total	Reference
	RDF	MB	MOD		
1987	12	44	49	105	EPA. (2006). An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000.
1995	41	95	26	162	J.V.L. Kiser and J. Menapace. (1995). <i>Integrated Waste Services Association, Washington, D.C.</i>
2000	26	70	13	102	Jonathan V.L. Kiser & Maria Zannes. (2000). <i>The IWSA Directory of Waste-To-Energy Plants.</i>
2010	15	64	7	86	Ted Michaels. (2010). Energy recovery council 2010 Directory of waste-to-energy facilities.
2016	13	60	4	77	Ted Michaels. (2016). Energy recovery council 2016 Directory of waste-to-energy facilities.

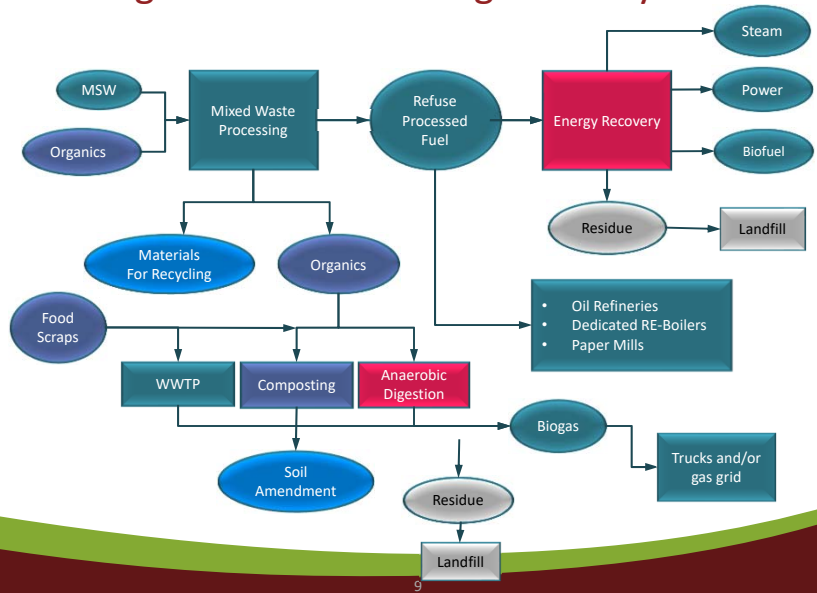


Conversion Systems may have Multiple Technologies, Pathways and Products



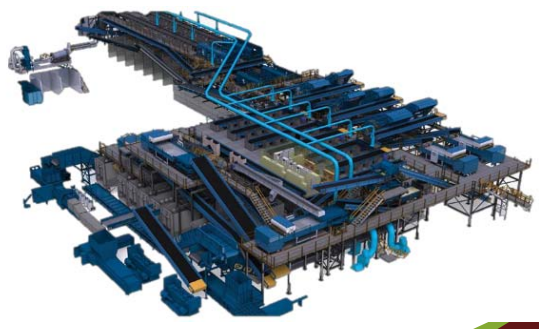


Modern Integrated Waste Management Systems are Complex



Advanced Conversion Processes Start with Mixed Waste Processing

- Recovers additional recyclables from mixed waste
- Focus on additional containers and removal of organics
- Residual stream suitable for energy recovery





Technology in MWP has Evolved

Heavy-Light Air Separator



Ballistic Separator



Optical Sorting Enhances Potential for Fuel Products





Sunnyvale, CA sMaRT Station



Increases recycling but residuals go to the landfill



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Engineered Fuel

- ✓ Fuel heating value over 8,000 BTU/LB.
- ✓ Chlorine content less than 0.3%, 3,000 PPM
- ✓ Moisture less than 15%
- ✓ Ash less than 15%
- ✓ 50% or greater biogenic carbon

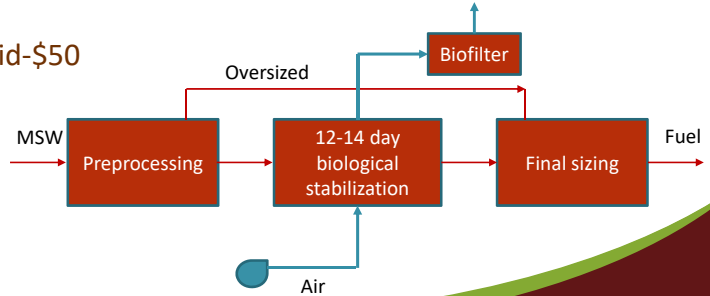


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Martinsburg, WV - Entsorga

- 500 tpd for MSW derived fuel for use in ARGOS cement facility
- Privately developed by Apple Valley Waste
- Construction commenced fall 2016
- Operational Spring 2018
- Estimated tipping fees mid-\$50



Entsorga Wilshire, UK





SpecFUEL® Faculty in Philadelphia

1,000 tpd of post recycling waste to 450 tpd of fuel



Consumers: Cement kilns



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Evergreen Community Power – Reading

- Combined Heat and Power facility providing steam and electricity to an associated 600 tpd OCC mill.
- Fluidized bed boiler
- Up to 1,000 tpd of processed construction and demolition debris.



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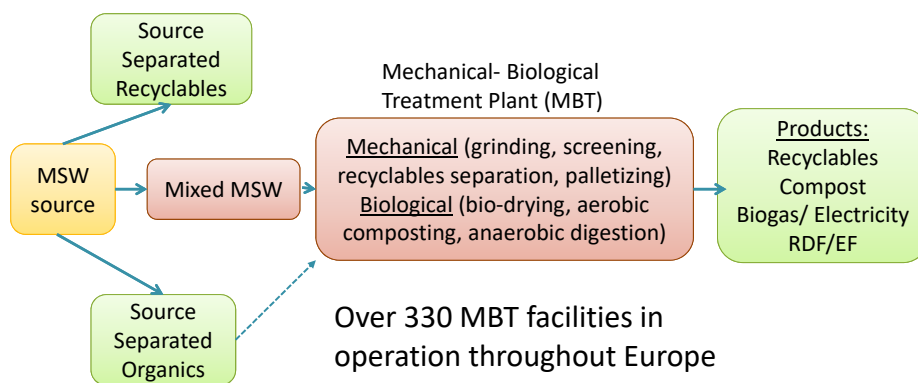


Engineered Fuel Regulatory Considerations

- At the state level a project may need various solid waste permits.
 - Solid waste receiving and processing
 - Solid waste beneficial reuse
- EPA Non Hazardous Secondary Materials
 - Certain waste streams are categorically exempt
 - C&D, tires, creosoted wood, papermill residuals
 - Seek a “Comfort” letter specify the fuel is not a regulated waste



Mechanical Biological Treatment (MBT)





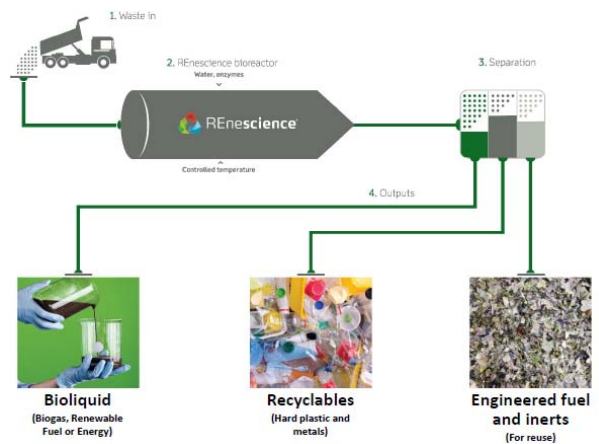
Fiberight – Hampden, Maine

- Construction started Spring 2017
- 600 ton per day design capacity
- Will serve the needs for residential and commercial waste disposal for 83 communities
- Products include recyclables and biogas
 - Soluble organics (food waste) process through AD
 - Cellulosic organics processed via hydrolysis and AD
 - Lignin, non-recyclable plastics processed to an engineered fuel
- Privately financed, \$72 per ton tipping fee
- Start up, Spring 2018



REnescience

- MSW processed through enzymatic separation
 - Biogas
 - Recyclables
 - SRF/RDF + inerts
- UK Plant scheduled will treat 132,000 tons per year
 - Will supply power for 9,500 homes





Anaerobic Digestion/Composting

- Biological decomposition of the organic material in absence of oxygen
- >25 commercial plants that take source separated organics
- Feedstock: Commercial food waste, residential SSO, co-digestion at WWTP and farms
- Two main type: high solids AD and low solids AD



CR&R – Perris, CA

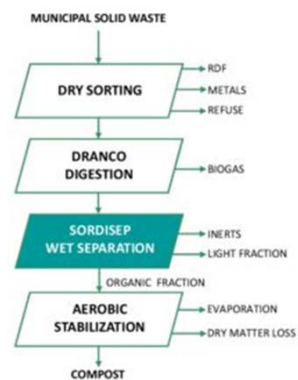
- \$100 million facility
 - 84,000 TPY operating;
 - 335,000 TPY planned capacity
 - High solids anaerobic digestion system
 - Feedstock: residential food scraps and yard waste, and commercial food waste
 - Generating CNG to fuel truck fleet





Dranco + Sordisep

- **DRANCO**
 - Can anaerobically digest a feedstock with dry matter content up to 40%
 - Plug-flow system, no mixing
- **SORDISEP**
 - Wet separation of digestate after DRANCO
 - Removes inerts and sand
 - Yields recyclables, fill, and high quality compost
- **Cleaning digestate makes it possible to accept 'dirty' feedstock at the front end**



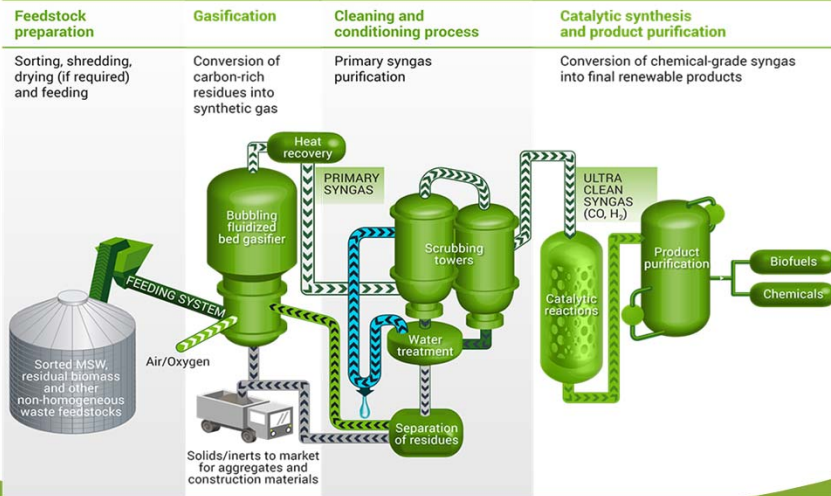
Waste-to-Biofuels: Enerkem, Alberta, Canada

- Refuse derived fuel for gasification
- Produces 10 mm gallon / year of ethanol and chemical intermediates
- City of Edmonton's Waste Management Centre:
 - Refuse Derived Fuel production facility
 - Enerkem Waste-to-Biofuels Facility
 - Advanced Energy Research Facility





Enerkem Process



* Municipal solid waste



Biofuel Subsidy

- Federal Renewable Fuels Program highly incentivizes the production of advanced cellulosic biofuels via tradable credits called RINS (Renewable Identification Numbers)
- MSW is considered a cellulosic feedstock RINS
- EPA proposes 2018 requirement of 238 million gallons of cellulosic biofuel in 2018, of that volume landfill gas projects are expected to produce 221 million gallon equivalents.





Energy/Fuel Product Values Versus Capex

Converting MSW to...	Product	Yield from 1 Ton MSW	Value Per Production Unit	Revenue Per Input Ton	Capital Investment for 1,000 tpd facility
	Power	500-650 kWh	@ \$0.05 / kWh	\$25-\$33	\$300 -400 million
	Engineered Fuel	8 -16 MMBTU	@ \$1.50 / MMBTU	\$12 - 24	\$50 – 100 million
	Ethanol (w subsidies)	50 gallons	@ \$4.00 / gallon	\$200	\$300 - 400 million



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Conversion Technologies have Different Risk Profiles

Alternative	Risks/Liability	Risk Summary
Processing for Recyclables and Fuel	Proven commercial technology	Low
Composting	Proven commercial technology	Low
Mass Burn Combustion	Proven commercial technology	Low
RDF Combustion	Proven technology; limited U.S. commercial experience	Moderate to Low
Anaerobic Digestion	Proven technology; limited U.S. commercial experience	Moderate to Low
Pyrolysis and Gasification	Previous failures at scale; no operating experience with large -scale operations in the U.S.; full-scale demonstrations nearing operation	High



Source: Gershman, Brickner & Bratton, Inc. 2017

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Summary

- Technologies capable of recycling / diverting up to 90% of MSW generation are available and operating today
- Private sector development and financing are available
- Indicated tipping fees in the \$60 – \$70 per ton range



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QUESTIONS & ANSWERS

What is important to you?



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