Appendix C. Biomass Conversion Matrix

		1. Biomass Conversion Technology		2. Feedstocks	3. Products
Thermochemical	Gasification	Fixed Bed	Downdraft Co-Current Fixed Bed Updraft Co-Current Fixed Bed Cross-Draft Fixed Bed Open Core Fixed Bed	**Any Organic Material** Examples: Agricultural wastes, hazardous organic wastes, industrial wastes. **Pretreatment:** Waste typically segregated. **Qualifications:** Dry MSW is favorable. Coal size distribution must be controlled to ensure good bed permeability. **Final Conversion Technology (Optional):** Fischer-Tropsch Catalytic Conversion	**Intermediate Products:** Combustible gases, liquids, tars, and inert fluidizing gases. **Final Products:** Electricity, Thermal Energy, Hydrogen, Ethanol and other alcohols, Diesel type fuels, Gasoline. **Co-products:** Charcoal, Ash, Carbon Dioxide.
		Fluidized Bed	Pressurized Circulating Fluidized Bed Atmospheric Circulating Fluidized Bed		
		Novel Design	Plasma Arc Gasifier 2-stage Gasifier Open Top Aqueous Phase Reforming		
	Pyrolysis	Fast Pyrolysis	Ablative Fast Pyrolysis Cyclonic Fast Pyrolysis Rotating Core Fast Pyrolysis Open Core Fast Pyrolysis	**Any Organic Material** **Pretreatment:** Sorting **Qualifications:** None	**Intermediate products:** Syngas and Charcoal **Final Products:** Bio-Oil and Charcoal **Co-products:** Electricity and Thermal Energy
		Slow Pyrolysis	Vacuum Pyrolysis Flash Pyrolysis	**Any Organic Material** **Pretreatment:** Sorting. **Qualifications:** Waste must be pre-sorted and processed to <6 mm (1 to 2 mm. preferred) and <10% moisture content to assure high heat transfer rate.	
Biochemical	Ethanol Production	Wet-Mill Fermentation		**Grains** Mostly: Corn **Pretreatment:** Separation of the oil, protein, fiber and the bulk of the nutrients from the starch	**Intermediate Products:** Mash, Sugar **Final Products:** Ethanol **Co-products:** Distillers grains plus solubles, Carbon Dioxide
		Dry-Mill Fermentation		**Grains, Sugars and Waste , Starches and Sugars** Examples: Grains (corn, sorghum, barley), Sugars (Sugarcane and beets), Beer, and other waste sugars and starches. **Pretreatment:** Grinding, cooking and fermentation	**Intermediate Products:** Starch, Sugar **Final Products:** Ethanol **Co-products:** Corn oil, corn gluten meal, corn gluten feed, carbon dioxide, liquid bio-fertilizers
		Lignocellulosic Biomass Fermentation		**Cellulosic/Woody Biomass** **Pretreatment:** Hydrolysis (Dilute Acid, Concentrated Acid, Enzymatic, Steam explosion)	**Intermediate Products:** Cellulose, hemicellulose. lignin **Final Products:** Ethanol **Co-products:** Carbon Dioxide, residual cellulose and lignin, electricity and thermal energy
	Anaerobic Digesters	Mesophilic Process or Thermophilic Process	Anaerobic activated sludge process Anaerobic clarigester Anaerobic contact process Anaerobic expanded-bed reactor Anaerobic filter Anaerobic fluidized bed Anaerobic lagoon Anaerobic migrating blanket reactor Batch system anaerobic digester Expanded granular sludge bed digestion Hybrid reactor Imhoff tank One-stage anaerobic digester Submerged media anaerobic reactor Two-stage anaerobic digester Upflow anaerobic sludge blanket digestion Upflow and down-flow anaerobic attached growth	Almost any organic material: paper, grass clippings, leftover food, sewages, animal wastes; and other forms of biomass such as distillers grains. **Pretreatment:** Sorting or screening to remove inorganic material. **Qualifications:** The material may need to be pre-processed and water added.	**Intermediate products:** N/A. **Final Products: Biogas,** Thermal Energy, Digestate. Co-products: Liquid and Solid Biofertilizers.
	Landfill	Bioreactor vessel		**Organic Wastes** **Pretreatment:** Sorting pre-treatment **Qualifications:** The waste must be contained, compacted and covered in a vessel	**Intermediate products:** Biogas composed of Methane, Carbon Dioxide, Nitrogen, Hydrogen, Hydrogen Sulfide and Oxygen. **Final Products:** Electricity, thermal energy, methane. CNG or LNG for vehicle fuel. **Co-products:** Carbon Dioxide for possible use in greenhouse operations, and Biofertilizers.
		Landfill Site		**Organic Wastes** **Pretreatment:** None **Qualifications:** None	
	Aerobic	Static Pile Enclosed Compost Turned Window In-Vessel Compost Transesterification		**Practically any Organic Waste** **Pretreatment:** Sorting **Qualifications:** A separation between organic and contaminants is necessary.	**Intermediate products:** None **Final Products:** Valuable Compost **Co-products:** Heat and Carbon Dioxide. (May be useful in a greenhouse environment or for heating)
Chemical	Biodiesel Production			**Oils, fats, used cooking oils, greases, methanol or ethanol and a catalyst** **Pretreatment:** Used cooking oils, yellow greases, and some tree oils are taken through an esterification process to remove fatty acid that should, preferably, be reduced to less than 1% (at least below 4%). **Qualifications:** Essentially any bio-oil, animal fat or tallow, used cooking oil, yellow/trap grease, plant or tree oil can be converted into biodiesel if the fatty acid content is low enough.	**Intermediate Products:** Oils fats or greases taken through transesterfication **Final Products:** Biodiesel **Co-products:** Glycerin, Soaps

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